Comparative Analysis of Certainty Factor and Dempster Shafer Theory Methods in Expert System by Using Open Decision Maker Tool (Case Study: Infectious Diseases in Toddler at Vaccine House)

Written by:

Rizka Fajriah, S.Kom.

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MASTER PROGRAM

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THESIS

Submitted as a Partial Fulfillment

of the Requirements for Master of Management Information System Degree

Concentrating on Business Information System

Gunadarma University

MASTER PROGRAM

GUNADARMA UNIVERSITY

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PAGE OF APPROVAL

Title	:	**Comparative Analysis of Certainty Factor and Dempster Shafer Theory Methods in Expert System by Using Open Decision Maker Tool (Case Study: Infectious Diseases in Toddler at Vaccine House)**
Name	:	**Rizka Fajriah, S.Kom.**
NIM	:	**92213139**
Date of graduation	:	February 26th, 2015

Approved by:

Board of Advisors

. . . . . .

(Dr. Riza Adrianti Supono)
Chairman

. . . . . .

(Prof. Dr. Yuhara Sukra, M.Sc.)
Coordinator of Master Program

. . . . . .

(Dr. Tb. Maulana Kusuma, S.Kom., M.Eng.Sc.)
Director of Graduate Master Program in Technology and Engineering

ABSTRACT

Rizka Fajriah, S.Kom., 92213139.

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Thesis. Master of Information System Management. Business Information System. 2015

Keywords: Certainty Factor, Dempster Shafer, Expert System, Open Decision Maker

(xvi+ 104 + appendix)

Expert system is a form progress of Information and Communications Technology. Development of an expert system can be performed in variety areas, including health. In its development required a result can be trusted by the user. Therefore it required the value of belief for any decision issued by the expert system.

In expert system, there are several uncertainty methods can be used namely Certainty Factor, Dempster Shafer, Naïve Bayes, Fuzzy Logic, etc. In this case, the developer must be good at choosing a method of calculation will be used in the expert system in order to provide the best results to users. Therefore, in this study will be performed the comparison between Certainty Factor and Dempster Shafer method using data infectious diseases in toddler. Both of methods have different ways of working in the calculation, but both are equally give results to support a decision.

In the comparative analysis of both methods will be used a decision support system tool namely Open Decision Maker with Analytical Hierarchy Process approach. From the comparison result of eight cases has been obtained that the Certainty Factor method have more higher belief values as big as 82.54%

than Dempster Shafer method as big as 17.46%, but significantly the value of belief between the two was not differ greatly.

Bibliography (1985:2014)

CURRICULUM VITAE

Rizka Fajriah, was born in Bekasi on September 7th, 1992. The educational background started from SDN Bintara Jaya II, Bekasi Elementary School from 1998 until 2004. She continued his education to SMPN 14 Jakarta Junior High School and graduated in 2007. On 2007, she was accepted in SMAN 59 Jakarta Senior High school and graduated in 2010. After graduated from senior high school, she continued to Gundarma University majoring in Information System. In 2011, she got Sarmag (Sarjana Magister) Scholarship Program from Gunadarma University majoring in Information System and finished the Undergraduate Degree on 2014. At present, she is taking the magister program majoring in Information System Management.

ACKNOWLEDGEMENTS

Praise and thanks raised to the Almighty, ALLAH SWT, for all blessing and also thanks utterance and good wishes sent to the prophet of Muhammad SAW so, with all the grants, that have given to author to finish author's thesis, which is titled "COMPARATIVE ANALYSIS OF CERTAINTY FACTOR AND DEMPSTER SHAFER THEORY METHODS IN EXPERT SYSTEM BY USING OPEN DECISION MAKER TOOL (CASE STUDY: INFECTIOUS DISEASES IN TODDLER AT VACCINE HOUSE)". This thesis is made to complete the requirement to finish study in Magister Management of Information System Program at Gunadarma University.

The author also would like to thank to everyone who cannot be mentioned one by one that has given the author supports, helps, spirits, and goodness. Special acknowledgements are dedicated to:

1. Prof. Dr. E. S. Margianti, S.E., MM, as Rector of Gunadarma University.
2. Prof. Suryadi Harmanto, S.Si., MMSI, as 2nd Vice Rector of Gunadarma University, who gave me the opportunity to join to SarMag Program.
3. Prof. Dr. Yuhara Sukra., M.Sc., as Coordinator of Postgraduate Program.

4. Dr. Yuhilza Hanum, S.Si., M.Eng., as Head of Master of Information System Management.

5. Dr. Tb. Maulana Kusuma, S.Kom., M.Eng.Sc., as Director of Postgraduate Program Master of Technology and Engineering

6. Drs. Haryanto, MMSI, as Director of SarMag (Sarjana Magister) Program.

7. Dr. Riza Adrianti Supono., S.Kom., MMSI., as the author's supervisor for her excellence in supervising Author with her enthusiasm, her inspiration, and her great efforts to explain things clearly and simply. Throughout author's thesis writing period, she provided encouragement, sound advice, good teaching, and lots of good ideas.

8. Mr. Remi Senjaya, S.T., MMSI who sincerely take care of us (SarMag students) and give us all information and needs in SarMag Program.

9. My beloved family, Badrudin (Father), Setiawati (Mother), Ashidieqi and Isdiyoko Putro (Brother), Ashifany and Tuti Susanti (Sister) for all supports, kindnesses, and affection they have to give.

10. All of SarMag lecturers, for support and knowledge given to author.

11. All SarMag staffs in Simatupang and Salemba Campus, for the supports.

12. All my friends, especially in SMSI-01, for a lot of supports, sharings, jokes, and joys. Thank you for giving happiness in SarMag environment.

13. dr. Piprim B. Yanuarso, Sp.A(K) for his knowledge expertise in toddler disease.

Jakarta, February 2015

Rizka Fajriah, S.Kom.

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CHAPTER I

INTRODUCTION

1.1 Background

Artificial Intelligence is one part development progress of Information and Communication Technology (ICT). In some fields, artificial intelligence has been widely applied to support and enable people to making a decision. One example is the development of expert systems in various fields, including health. Expert systems are computer based systems that use knowledge, fact and reasoning technique in solving a problem that usually can only be solved by an expert in the field [1].

Representation of the expert system is done based on the facts, rules, and approaches in the form of reasoning, one of them is Forward Chaining approach (trace forward). In addition to using a technique of reasoning, would be much better if the expert system is supported by the certainty values of a hypothesis. In obtaining the certainty value, in expert system there are several methods used to calculate the value of the certainty of the results such as: Certainty Factor method, Naïve Bayes, Dempster Shafer and Fuzzy.

In the development of expert systems, researchers must be proficient in considering and choosing what methods will be used to obtain the best results of an expert system that has been built. This is necessary so that the expert system can provide accurate results to the user so as to provide confidence and allows

users to take a decision to resolve the problem. In this case, it will be made a comparison between the two methods of expert system method there are Certainty Factor and Dempster Shafer. Both methods have a different way of working, the certainty factor method easier in the process of calculating the level of trust, and the Dempster Shafer methods have to go through a fairly complex calculation. Thus it would be a comparison between two methods is the complexity of calculations affects the results of the high level of trust. Comparison of the two methods will be made by means of manual calculations and the use open decision maker tool. The data used to perform a comparative analysis is data contained in the application of web-based expert system for diagnosing infectious diseases in toddlers [14]. Certainty factor is a method for measuring the degree of certainty of an expert thinking of a problem by combining some facts that occurred. Whereas, Dempster shafer theory is representation, combination and propogation of uncertainty, which it has some characteristics according to the way of thinking an expert but with strong mathematical foundation. Each of these approaches has a way of working or different calculation processes, but has a same goal of providing the results accuracy of a hypothesis. The results of both approaches can be analyzed then compared with each other, so that researchers can consider which method is better for use in building an expert system.

1.2 Problem Statement

Based on the background described above, the formulation of the problem is obtained as follows:

1. How to represent facts and expert knowledge about infectious diseases in toddler to build an expert system?
2. How does the Certainty Factor and Dempster Shafer in providing a degree of trust for each hypothesis?
3. How do test and the results of the comparison accuracy or confidence in the manual calculation between Certainty Factor and Dempster Shafer method?

1.3 Scope of The Work

Boundary problem made to clarify the scope of the discussion will be presented in writing. Therefore, the researchers made the boundary problem of this paper as follows:

1. Knowledge of toddler's infectious diseases adopted by the expert system come from pediatricians, research, articles, it will be made as production rules in the knowledge base.
2. The calculation of certainty value and conclusions made in an expert system using Certainty Factor (CF) and Dempster Shafer.
3. Analysis and comparison the results of two methods will be conducted by using the Open Decision Maker tool.

1.4 Objectives of The Research

As for the objective of this paper is as follows:

1. Adopt knowledge and minds of pediatrician who will be stored in the knowledge base and represent it in forms of calculation.
2. Using Certainty Factor and Dempster Shafer method for diagnosis infectious diseases in toddlers.
3. Comparing certainty value results between calculation of Dempster Shafer and Certainty Factor method.

1.5 Benefits of The Research

Research that has been conducted is expected to give benefits to the parties concerned, among others:

1. For the researcher, expected to be a guide or reference for research in the field of information systems in the future.
2. For other researchers, expected to be one of the sources of literature for similar research activities.
3. For the physician or health authorities, expected to become a tool in diagnosing the disease.

CHAPTER II

LITERATURE REVIEW

2.1 Artificial Intelligence

Artificial intelligence is one of computer science which utilizes computer that can behave intelligent like humans [2]. Artificial intelligence can also be defined as a part of computer science that make the machine (computer) can do the job and as good as humans do. So that the machine can be intelligent (as well act like humans) it should be given sufficient knowledge and have the ability to reason. Two main parts required for the application of artificial intelligence [3]:

a) Knowledge base: contains facts, theories, ideas and relationships between each other.

b) Inference engine: the ability to draw conclusions based on experience

2.2 Expert System

Expert Systems (ES) is a software package of decision making or problem solving to achieve an equivalent level of performance or even more with a human expert in some specialized field and usually narrow problem area. The basic idea behind ES, applied artificial intelligence technology is simple. Expertise transferred to a computer expert. This knowledge is then stored in the computer, and the user running the computer for specific advice is necessary. ES

asks the facts and makes inferences and come to a particular conclusion. Then, like a human consultant, he advises and explains non expert. If necessary, the logic behind the advice will be given. Currently ES is used in thousands of organizations and systems to support multiple tasks [4].

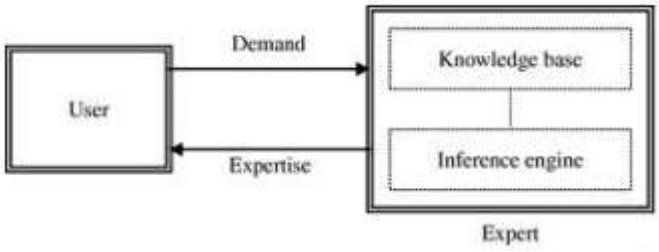

Figure 2.1: The Basic Concept of Expert Systems

2.2.1 Comparison of Conventional System and Expert System

Expert with expert systems have some differences. There are comparisons between the ability of an expert with an expert system [3].

a) Conventional System

- Information and process generally combined in a sequential program
- The program is never wrong
- Does not explain why or how the input required is obtained
- Data must complete
- Changes to the program troublesome
- The system works if it is complete

b) Expert System

- The knowledge base is separate from the processing mechanism (inference)
- Programs can make mistakes
- Explanation is part of the expert system
- Data is not necessarily complete
- Changes to the rules can be easily
- The system operates in heuristics and logical

2.2.2 Advantages of Expert Systems

There are advantages of expert system [3]:

1. Allows the layman can do the work of the experts.
2. Can make the process repeatedly automatically.
3. Save the knowledge and expertise of the experts.
4. Improve the quality by giving consistent advice and reduce errors.
5. Improving results and productivity, because the expert system can work faster than humans.
6. Have the ability to access knowledge.
7. Increase the capability in solving problems.
8. Save time in decision making.

2.2.3 Disadvantages of Expert Systems

Besides having several advantages, expert systems also have some disadvantages, among others [3]:

1. Problems in getting knowledge where knowledge can't always be obtained easily because sometimes experts of the problem that we create does not exist, and even if there is sometimes approach owned by different expert.
2. To create an expert system that is truly high quality is extremely difficult and costly for large development and maintenance.
3. System may not be able to make a decision.
4. Expert systems are not 100% favorable, although still not perfect or always right. Therefore, it needs to be reexamined carefully before use.

2.2.4 Structure of Expert System

Expert system has two main parts, namely [3]:

1. Development environment, which is the part used to incorporate expert knowledge into an expert system environment.
2. Environmental consultation, which is the part used by non-expert users to gain knowledge.

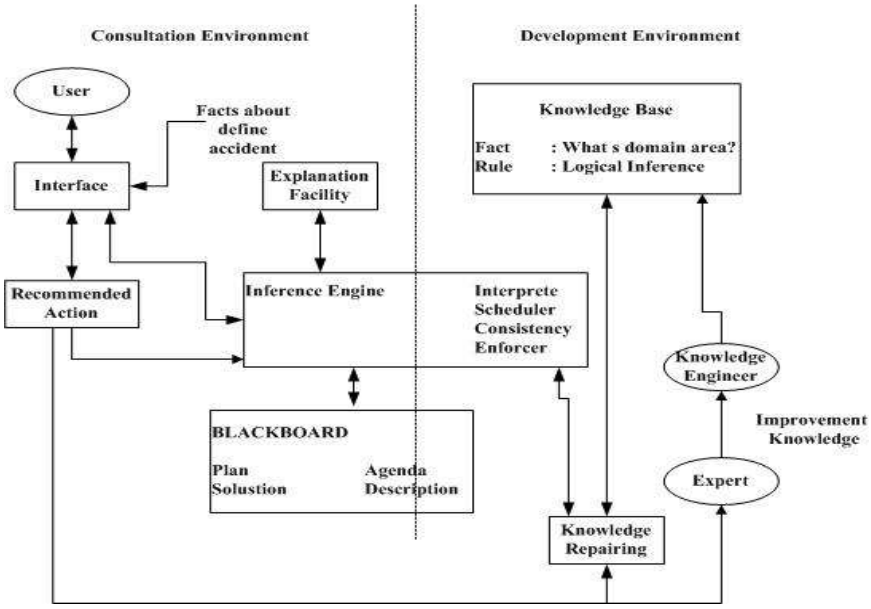

Figure 2.2: Structure of Expert System [3]

The components that exist in the expert system are as follows:

a) User Interface

The mechanism is used by the user and expert systems to communicate. Receive information from the user interface and convert it into a form that can be accepted by the system. Besides the interface receives from the system and presenting it in a form that can be understood by the user.

b) Knowledge Base

The knowledge base contains the knowledge for understanding, formulation, and problem solving. Knowledge that can be derived from the experts, books, databases, research and images.

There are two forms of approach to knowledge base [3]:

- Rule-based Reasoning

In the rule-based reasoning, knowledge is represented using IF-THEN rules of the form. This form is used when we have a number of expert knowledge on a particular issue, and the expert can solve the problem sequentially. In addition, this form is also used when needed explanation of the trail (the steps) the achievement of a solution.

- Case-based Reasoning

  In case-based reasoning, knowledge base will contain solutions that have been achieved previously, then lowered a solution to the current situation (the facts). This form is used when the user wants to know more on the cases are almost the same (similar). In addition, this form is used when we have had a number of situations or specific cases in the knowledge base.

- Knowledge Acquisition

  The acquisition of knowledge is the accumulation, transfer and transformation of expertise in solving the problem of the source of knowledge into a computer program. In this stage the knowledge engineer trying to absorb knowledge to transfer to the knowledge base. Acquired knowledge is procedural knowledge (what to do, in the form of rules, procedures, methods, etc.) as well as declarative knowledge (including and excluding, in the form of facts, concepts, etc.). The knowledge obtained from experts, equipped with books, databases, research reports and user experience. There are several challenges in

making acquisitions, incomplete knowledge, wrong knowledge, knowledge and ability to explain the different views of some experts.

Methods of knowledge acquisition:

- Interviews: The most widely used method, which involved discussions with experts directly in an interview.
- Analysis of the protocol: in this method the expert is asked to do a job and revealing his thought process by using words. The work was recorded, written, and analyzed.

c) Inference Engine

Inference engine is the brain of the Expert System, also known as an interpreter of rules (rule interpreter). This component contains a mechanism mindset and reasoning used by experts in solving a problem. Inference engine is a computer program that provides a methodology for reasoning about the information in the knowledge base and in the workplace, and to formulate conclusions.

Work inference engine includes:

- Determine which rules will be used
- Presenting questions to the user, when needed.
- Adding memory response to the Expert System.
- Summing new facts of a rule.
- Adding this fact into memory.

There are 2 ways of doing inference:

- Forward Chaining: matching a fact or statement of facts first started to test the truth of the hypothesis. Suitable inference method is used to deal with control problems and forecasting.
- Backward Chaining: matching facts or statements starting from the first hypothesis, and to test the truth of this hypothesis to look for the facts that exist in the knowledge base. Workplace / Blackboard

Workplace is the area of a set of working memory (working memory), is used to record ongoing events including temporary decision.

d) Explanation Facility

The ability to track how a conclusion can be drawn is very important for the transfer of knowledge and problem-solving. Explanation facility is an additional component that will enhance the ability of an expert system.

e) Knowledge Improvement

Experts have the ability to analyze and improve their performance as well as the ability to learn from its performance. These capabilities are important in learning computerized, so the program will be able to analyze the causes of success and failure that caused also evaluate whether knowledge-knowledge that is still suitable for use in future.

2.3 Data Collection Methodology

Below is a description of the research methodology [15]:

2.3.1 Data Sources

The data source is divided into two primary data and secondary data. Primary data is data obtained by researchers directly (first-hand), while secondary data is data obtained by researchers from existing sources. Examples of primary data are the data obtained from respondents through questionnaires, focus groups, and the panel, or also data from interviews with informant researchers. Examples of secondary data such records or documentation of the company in the form of attendance, payroll, financial statements of the company publications, government reports, datas obtained from the magazine, and others.

2.3.2 Data Collection Technique

Data collection method is a technique or method to collect data. Method designating a way so that it can be shown through the use of questionnaires, interviews, observation, testing, documentation, etc. While Instruments Data Gatherer is a tool used to collect data. Because of the instrument, the instrument can be checks lists, questionnaires (questionnaire open / closed), interview, pictures and other camera. The three data collections techniques used are questionnaires, observations and interviews.

1. Questionnaires

Questionnaire was conducted data collection techniques by providing a set of questions or statements to others as respondents to answer. Some things need to be considered in the preparation of the questionnaire related to the principle of writing questionnaires, measurement principles and physical appearance. Writing Principles questionnaire regarding several factors, among others: The content and aim of the questions means that if the content of questions intended to measure then there must be a clear scale in the answer choices, the language used must be adapted to the abilities of the respondents, it is impossible to use language that is full of terms in English the respondents who do not understand English, etc., the type and form of the question whether open or closed. If the open means that the answer given is free, whereas if the enclosed statement, the respondents were only asked to choose the answers provided.

2. Observation

Observation is one of the techniques of data collection that not only measures the attitudes of respondents (interviews and questionnaires), but also can be used to record a variety of phenomena that occur (situation, condition). This technique is used when the research is to study human behavior, work processes, phenomena of nature and conducted in respondents who are not too big.

3. Interview

Interview is conducted data collection techniques through face to face and question and answer directly between the data collector and researcher of the resource or data source. Interview on large sample studies usually only done as a preliminary study because it is impossible to use the interview at 1000 respondents, whereas the small sample interview techniques can be applied as data collections techniques (generally qualitative research). The interview is divided into structured and unstructured interviews. Structured interview means researchers have to know exactly what information to be extracted from the respondents that the list of questions has been made to systematically. Researchers can also use tools tape recorder, photo camera, and other materials that can help smooth the interview. Unstructured interviews are free interviews, namely the researchers did not use the interview guide containing questions to be asked specifically, and only load the key points of the problem to be explored respondents.

2.4 Certainty Factor

Expert system must be able to work in uncertainty (Giarattano and Riley, 1994). A number of theories have been found to resolve uncertainties, including the classical probability, the probability of Bayes (Bayesian probability), based on the set of the classical theory of Hartley, based on the probability theory of

Shannon (Shannon theory based on probability), Dempster-Shafer theory, Zadeh Fuzzy theory and the certainty factor.

Factors certainty was introduced by Shortliffe Buchanan in the manufacture of MYCIN. Certainty factor (CF) is a clinical parameter values given MYCIN to show how much confidence.

The basic formula certainty factor [5]:

$$\mathbf{CF(H,E) = MB(H,E) - MD(H,E) \ldots\ldots\ldots\ldots\ldots\ldots} \quad (1)$$

Description:

CF(H,E) : certainty factor of a hypothesis H which is affected by symptoms (evidence) E.

MB(H,E) : the size of the increase in confidence (measure of Increased belief) against the hypothesis H that are affected by the symptoms of E.

MD(H,E) : the size of the increase distrust (Increased measure of disbelief) against the hypothesis H that are affected by the symptoms of E.

The basic form formula certainty factor of a rule IF E THEN H is as shown by the following equation 2:

$$\mathbf{CF(H,e) = CF(E,e) * CF(H,E) \ldots\ldots\ldots\ldots\ldots\ldots} \quad (2)$$

Description:

CF(E,e) : certainty factor is influenced by the evidence E evidence e.

CF(H,E) : certainty factor hypothesis assuming the evidence is known with certainty, i.e. when the CF (E, e) = 1.

CF(H,e) : certainty factor hypothesis influenced by evidence e.

CF formula for some rules that lead to the same hypothesis can be written as follows:

CF = CF(R1) + CF(R2) – [CF(R1) * CF(R2)] ; value CF(R1) and CF(R2) > 0

CF = CF(H) CF(R1) + CF(R2) + [CF(R1) * CF(R2)]; value CF(R1) and CF(R2) < 0 ……..… (3)

There are two values certainty factor, namely:

- Value rule certainty factor whose value is attached to a rule / rule specified and the value provided by the experts.
- Certainty factor value given by the user to represent belief in the premise (e.g., symptoms, conditions, characteristics) experienced by users.

In the implementation of the disease diagnosis expert system will use the formula:

CF(R1,R2) = CF(R1) + CF(R2) – [(CF(R1) x CF(R2)] ……..… (4)

For a given value of CF is positive. The formula can then be applied to several different rules are stratified. CF value of each premise / symptom is the value given by an expert or literature that support.

The advantages of the Certainty Factor method are [6]:

a) The method is suitable for use in an expert system to measure something for sure or not for sure whether diagnose the disease as an example.
b) Calculations using this method in a single count two only can process the data so that the accuracy of the data can be maintained.

While the disadvantages of methods Certainty Factor, among others [6]:

a) The general idea of modeling human uncertainty by using numerical methods certainty factor is usually debated. Some people would dispute the notion that the formula for the certainty factor above method has some truth.
b) This method can only process the uncertainty / certainty only two data alone. Needs to be done several times for data processing data more than two pieces.
c) The value of a given CF is subjective because every expert assessment may vary depending on the knowledge and experience of experts.

2.5 Dempster Shafer Theory

Dempster-shafer method is first introduced by Dempster, who did an experiment to an uncertainty model with probability range as a single probability. Then in 1976, Shafer published the Dempster theory in a book entitled

Mathematical Theory of Evident. A way to reason about degrees of belief is provided by Dempster-Shafer method. [7]

Generally, Dempster-Shafer is written in an interval: [8]

[Belief, Plausibility] ..... (5)

Belief (Bel) is measurement of evidence power in supporting a proposition assemblage. If it is worth 0 (zero), it indicates that there is no evidence; if it is worth 1, it shows that there is certainty. According to Giarratano and Riley, the function of belief can be formulated as:

$$\mathbf{Bel\ (X)= \sum_{Y \subseteq X} m(Y)} \qquad \text{.....(6)}$$

While Plausibility (Pls) is denoted as:

$$\mathbf{Pls(X)= 1 - Bel(X') = 1- \sum_{Y \subseteq X} m(X')} \qquad \text{…….....(7)}$$

Where:

Bel(X) = Belief (X)

Pls(X) = Plausibility (X)

M(X) = mass function of (X)

m(Y) = mass function of (Y)

In Dempster-Shafer theory, the set of the universe of discourse of a set of hypotheses given the notation θ, where it is assumed that the hypotheses used is

grouped to an individual environment. To show how big the belief of evidence to a certain hypotheses is called probability density function which is given notation(m).

In the application of expert system in a disease, there is some evidence which will be used to uncertainty factor in taking decision for diagnosis of a disease. To solve that some evidence in Dempster-Shafer theory, it is used a rule known as Dempster's Rule of Combination.

$$m1 \oplus m2(Z) = \frac{\sum_{X \cap Y = Z} m1(X) m2(Y)}{1 - \sum_{X \cap Y = \theta} m1(X) m2(Y)}. \quad \text{…….....} \ (8)$$

Where:

m1⊕ m2(Z) = mass function of evidence (Z)

m1(X) = mass function of evidence (X)

m2(Y) = mass function of evidence (Y)

K = the amount of evidential conflict

Calculating process of belief percentage is done by the following steps:

1. Determining rule based on basic knowledge
2. Determining value of density (m) and m(θ) = 1- m1{x} using equation (5)
3. Calculations using Dempster's Rule of Combination using equation (6)
4. Determining the greatest density with Max {m {}}

2.6 Decision Support System

The concept of Decision Support Systems (DSS) was first proposed in the early 1970s by Michael S. Scott Morton with the term Management Decision System. The system is a computer-based system intended to help decision makers to utilize data and models to solve certain problems that are not structured. DSS term refers to a system that utilizes computer support in the decision making process.

The method used in the Decision Support System one of them is AHP (Analytical Hierarchy Process). AHP was developed by Thomas L. Saaty, a mathematician. This method is a framework for effective decision making on complex issues by simplifying and speeding up the decision process by solving the problem into parts, arranging parts or variables in a hierarchical arrangement, members of the numerical value on the subjective judgment of the importance of each variable and synthesize these considerations to set the variables which have the highest priority and act to affect the outcome of the situation. The AHP method helps solve complex problems by structuring a hierarchy of criteria, stakeholders, with interesting results and considerations for developing weight or priority. This method also incorporates the strength of feeling and logic concerned on various issues, and synthesize diverse considerations into results that matched our estimate intuitively as presented on the consideration that has been made (Saaty, 1993). There are the advantages and disadvantages in the AHP method:

- Advantages

  1. The hierarchical structures as a consequence of the selected criteria to the sub-sub-criteria are most in.
  2. Taking into account the tolerance limit of validity until inconcentration as criteria and alternatives are chosen by the decision makers.
  3. Taking into account the durability or resistance output sensitivity analysis of decision-making.

  Method of "pairwise comparison" AHP has the ability to solve problems examined multi objects and multi-criteria based on the comparison of the preferences of each element in the hierarchy. So this model is a comprehensive model. Decision-makers determine the choice of a pair of simple comparisons, establish priorities for alternative sequences. "Pairwaise comparison" AHP using existing data are qualitative based on perception, experience, intuition so felt and observed.

- Disadvantages

  1. Dependence AHP model on the main input.

     The main input in the form of an expert perception so that in this case involves the subjectivity of the experts but it is also a model becomes meaningless if the experts give an incorrect assessment.

2. The method of AHP is only a mathematical method without any statistical testing so no confidence limit of the true model of the form.

The steps and process Analysis Hierarchy Process (AHP) is as follows:

1. Defining the problem and goal setting. If AHP is used to select an alternative or arrange alternative prioriras, at this stage of development alternatives.
2. Formulate the problem into a hierarchy so that complex problems can be seen from the detailed and measurable.
3. Preparation of priority for each element in the hierarchy problem. This process results in weight or contributing elements to the achievement of objectives so that the element with the highest weight has priority handling. Priorities resulting from a matrix perbandinagan pairs between all elements at the same hierarchy level.
4. Perform testing consistency of the comparison between didapatan elements at each level of the hierarchy.

While the steps "pairwise comparison" AHP is as follows:

1. Collecting data of the object under study.
2. Calculate the weight of paired comparisons of data from respondents to the method of "pairwise comparison" AHP based on the results of questionnaires.

3. Calculate the average ratio of the consistency of each respondent.
4. Treatment with the method of "pairwise comparison" AHP.
5. After the treatment, it can be concluded their consistency with, if data is inconsistent then repeated with the retrieval of data as before, but if otherwise then classified the data which can then be searched weighted beta value (b).

2.7 Open Decision Maker

The Open Decision Maker (ODM) is designed to support a user in a decision making process. For this process ODM uses the Analytic Hierarchy Process (AHP) method. This method is similar to the value benefit method, but it also compares the rating quality for all comparisons and shows the consistency of the decisions which have been made

Use the AHP method it is also possible to rate alternatives with an inconsistency, but the inconsistency is displayed in the consistency ratio CR. The CR can be seen as the quality of the weightings. A high CR is a sign of random/very inconsistent ratings. This additional information the quality of decisions can be improved. ODM will guide the user from start to finish through the decision making process step by step with a user friendly graphical interface [9].

2.8 Infectious Disease in Toddler

There are a few infectious diseases in toddlers [10]:

1. Roseola Infatum

Roseola Infatum is a contagious viral disease in infants or toddler that causes a rash and high fever. Roseola usually affects toddler aged 6 months to 3 years. The cause is the herpes virus types 6 and 7. The virus is spread through saliva splashes patients. The incubation period (time from infection to onset of symptoms began) is about 5 to 15 days. The disease usually lasts for 1 week.

Symptoms: Fever arise suddenly reach 39.4 to 40.6° Celsius and lasts for 3 to 5 days. Despite the high fever, but the toddler remained conscious and active. At body temperature started to increase, 5-10% of patients experienced febrile seizures (seizures due to high fever). Can swelling of lymph nodes in the back of the head, neck next to the side and behind the ears, spleen also enlarge slightly, on the fourth day the fever usually begins to fall, approximately 30% of toddler have a rash (redness of the skin) is flat and prominent especially in the chest and abdomen and sometimes spreads to the face, arms and legs. The rash is not itchy and lasts for a few hours to 2 days.

Treatment: Keep toddler plenty of rest, lower the fever with paracetamol special for baby (check the recommended age on the packaging).

Complications: If the toddler's temperature is very high, he may experience a febrile seizure (attack may occur when a viral infection accompanied by high fever).

2. Red Cheek Syndrome (Parvovirus B19)

Parvovirus B19 is a virus that generally and only affects humans. Approximately half the adults must have been exposed to possible during toddlerhood or adolescence.

Symptoms: It starts with fever and respiratory distress. The rash appears as a punch on both cheeks. After passing two to four days, the rash spreads to the body row, arms and legs. For several days before the rash appears, the disease is easily transmitted. Toddlers are usually not very ill and the pain will improve within 7-10 days.

Treatment: Give special baby paracetamol (check the recommended age on the packaging) to reduce fever, or treat the itching. Once the toddler recovers from parvovirus infection, the toddler usually has immunity and further protected from this infection in the future.

Complications: The disease can be problematic when chronic, as it can lead to acute anemia. Avoid contact with toddler infected with parvovirus pregnant women because it can cause miscarriage.

Prevention:

- There is no vaccine or medicine that prevents parvovirus B19 infection.
- Frequent hand washing has been recommended as a practical and good to reduce the spread of parvovirus.

- Increase the separation between the affected people from work, toddler care, school or other facility is not likely to prevent the spread of parvovirus B19, because the sufferer can infect before arise.
- Pregnant women do not need to be away from the workplace affected by the outbreak of fifth disease in connection with the foregoing. Is this the first place to be away from work is a woman's own decision after consider with families, physicians and employers.

3. Impetigo

Impetigo is a skin infection that often occurs in toddler, often called pyoderma. Impetigo usually suffered by toddler 2 to 5 years old. The cause is the bacteria Staphylococcus aureus or Streptococcus hemolytic.

Impetigo is composed of two types, namely:

a. Impetigo crustosa is a disorder that occurs around the nostrils and mouth. The characteristic of impetigo is skin redness and blisters that break down quickly, leaving a thick scab yellow color similar to honey. When the scab is removed, abrasions visible underneath.

b. Bullous impetigo / vesico bullosa that often occurs in the armpits, chest, and back. Characteristics that redness in the skin and bubbles (such as cigarette exposed skin to fire known as chickenpox), containing pus fragile. Chickenpox is highly contagious fire and move from one part to another part of the skin. If occurs in newborns, the infection can spread

throughout the body via the bloodstream. This disorder can be accompanied by fever and cause serious infection.

Symptoms: There is a rash of small blisters around the nose and mouth or ears of toddler, which would break up and harden to form a yellow-brown scab. This disease can be transmitted when the blisters are still discharge and crusty, until two days after treatment began.

Treatment: Oral antibiotics or antibiotic cream prescribed by a doctor.

Complications: Side effects are rare, but because the disease is transmitted, this situation needs to be addressed immediately.

4. Chickenpox

Chickenpox is a disease that is often found in toddler. Chickenpox is caused by varicella zoster virus. This virus attacks the skin by forming sores (lesions) that contain fluid. This viral infection usually affects infants aged 9 months and older.

Symptoms: Chickenpox begins with an uncomfortable condition of the body, a rash and sometimes slightly increased body temperature (above 37° Celsius). After one or two days, appeared red spots and blisters become filled with water. Usually begin to appear in the body, then spreads and dries into a crust and peeling. Toddler began infected since one or two days before the rash appears until all the spots dry up and flake off.

Treatment: Usually parents do not need to bring the toddler to the doctor, but was not sure if the toddler had chicken pox or not , or the toddler is very uncomfortable and fussy. Give your toddler lots of fluids and paracetamol special

baby (check the recommended age on the packaging), to lower the body temperature. Bath with lukewarm water with a little bicarbonate of soda can help relieve itching or rub spots with calamine lotion. If the toddler wakes at night because of the itching, antihistamines can also relieve the symptoms (both are available at pharmacies). Wear loose clothing toddler made from cotton and temporarily remove the diaper to relieve itching. Strive not to be a toddler infected with other diseases resulting in complications. For example, do not allow toddlers to play outside with his friends and keep it away from anything that toddlers can make nodules broke. If the nodule rupture, the possibility of bacterial infection so bigger. If this happens, toddlers should be given antibiotics even if not necessarily patient at the hospital.

Complications: In rare cases, chickenpox can lead to encephalitis (inflammation of the brain). If the toddler had chickenpox, make sure he is not anywhere near pregnant women in the first half of pregnancy, and never had chickenpox before. Pregnant women who had chicken pox can be at risk of miscarriage or give birth to deformed babies. Women who do not have immunity and will soon give birth too risky because it can cause the baby is born with chickenpox.

Prevention: Prevent the vaccination. To prevent the possibility of contracting chicken pox or vaccination can be given. If exposed after vaccination, usually not until severe. Vaccination usually given at one year of age up because at this age the baby no longer have immunity from the mother. Power protection this vaccine can till 97% and can be repeated when the toddler was 5 years old.

5. Whooping Cough

Disease which is also called the 100 day cough is a disease that is highly contagious respiratory infection. This disease is more common in toddler, especially under the age of 2 years. Whooping cough can also occur in adults, but not dangerous. Become more dangerous if it occurs in toddlers and the elderly. The disease is caused by the bacterium Bordetella pertussis and sometimes by Bordetella pertussis. Transmission through coughing or sneezing of infected people.

Symptoms: Early symptoms of whooping cough, flu, and after two weeks of a new toddler started coughing. It could also be a toddler choking or vomiting and sometimes breathing sounds when breathing or coughing after. It took weeks to subside coughing attack. This bacterial infection with mucus clogging the air hole and could last about four weeks after the cough started. If the toddler is coughing constantly and for a long time, should visit a doctor to get a diagnosis and to prevent infecting others.

Treatment: Give your toddler foods that are easily swallowed and gave a lot of drinking. Help him out phlegm with laid him on a parent's lap and pat his back. The doctor will also prescribe antibiotics. Provide nutritious foods that are easily digested bit by bit. Avoid foods that contain lots of sugar, artificial sweeteners, and fried foods.

Complications: In severe cases, the toddler may need to be hospitalized to receive oxygen therapy and rehydration treatment. Sometimes severe coughing

attacks that can cause inflammation in the lungs and makes toddler susceptible to lung infection. Secondary infection, although rare, can trigger pneumonia and bronchitis. Avoid contact with other babies at risk of complications.

6. Rubella (German Measles)

Rubella is similar yet different measles virus causes and only attack once in a lifetime. Although viruses cause different, but rubella and measles (rubeola) have some similarities. Rubella and measles, is an infection that causes redness of the skin on the sufferer. Rubella is a serious illness that could potentially be a fatal disease which can lead to disability and death.

Symptoms: Rubella begins with a rash followed by flu freckles that appear in one or two days beginning on the face, then the rest of the body. Glands at the back of the neck will swell. Rubella virus began to attack before the rash appears, until at least four days after the rash is gone. In recent years, the disease is rare because kids usually get a shot against measles, mumps, rubella, at the age of about 12-15 months.

Treatment: Give the toddler a cold drink, wear light clothing and toddler with special baby give paracetamol (check the recommended age on the packaging) to lower the body temperature.

Complications: Although including mild infection in toddler, keep toddler of pregnant women over four months, or women who are trying to become pregnant. When toddler come near the pregnant woman before knowing the disease, tell the woman to be able to consult a doctor as soon as possible. This needs to be done to

find out if he has had the immune system, as these infections can lead to the baby birth defects.

Prevention: For toddler under five, at the age of 15 months or 12 months (if not immunized against measles) vaccination can be given Measles Mumps Rubella (MMR), to prevent the high risk of harm to health.

7. Mumps

Mumps is an acute viral infectious disease of the salivary glands (parotid, especially). Patients can transmit the disease from ± 7 days before onset of symptoms until the disease ± 9 days thereafter. Transmission can occur through: a splash of saliva (droplet infection), the tools used to eat and drink together. The disease is mostly elementary school age toddler (between 5-9 years). The cause is the mumps virus from the family Paramyxoviridae.

Symptoms: Symptoms of mumps is clear, that is swollen and tender glands under the ears and under the chin. Toddler suffered fever, headache, dry mouth, difficulty chewing and swallowing. The disease is caused by this virus are usually harmless; infection started a few days before the glands swell until flat back. Lately mumps is rare, because usually the toddler is getting an injection of MMR at the age of about 12-15 months.

Treatment: Compress the toddler with lukewarm water to reduce the fever give paracetamol special for baby (check the recommended age on the packaging) and / or ibuprofen special baby (when she's over six months, check the recommended age on the packaging). Give plenty to drink but not fruit juice, because fruit juice

can produce saliva, which can cause pain. No need to see a doctor unless the toddler complains of abdominal pain, feel pain, or rash multiply.

Complications: Although rare, mumps can lead to meningitis or encephalitis (inflammation of the brain). In addition mumps are also at risk (albeit small) interfere with the function of the testes in boys.

Prevention: Avoid contact with the patient, increase endurance, immunizations (usually in the form of MMR immunization).

8. Measles (Rubeola, Measles 9 days)

Measles is an infectious disease in infants who were present throughout the year regardless of the season. Although infected only once, did not anticipate that the toddler until complications. The virus can live and spread through the air. Measles, which the foreign terms are called measles, is caused by the measles virus or measles virus or morbili (MV) of the paramyxovirus family. Measles attack only once in a lifetime, if small time the toddler has been exposed to measles then after that he normally would not be exposed again.

Symptoms: Symptoms of measles begins with a heavy cold, hard coughing, and watery eyes. White patches in mouth are the first sign. Toddler will feel uncomfortable, high fever, and difficult to see the light. The rash appears on the third or fourth day, usually behind the ear, and then spread to other body parts. The spots will be flushed and more and more, but not itchy. The illness usually lasts about a week. Measles is highly infectious and potentially serious viral disease, but usually rare since most toddlers have received the MMR shot at age

12 to 15 months. The disease is very contagious since a few days before the rash appears until five days after the rash disappears.

Treatment: Visit the doctor or do not need to bring the toddler to the doctor because it could potentially infect other toddler. Give plenty to drink (warm water can relieve coughing) and give special baby paracetamol (check the recommended age on the packaging) to lower the body temperature. Vaseline will protect the skin around the lips. Rinse crust on the edge of the eye, and darken the room when the light bothered him. Because the disease is derived from the virus, can be treated with antibiotics, but the doctor may give him to a secondary infection.

Complications: Infection ears and lungs, vomiting and diarrhea may occur two days after the rash appears. The disease is also a small risk of causing pneumonia or ensefasilitis, disorders of the lungs or ears.

Prevention: Do measles immunization in toddler. It is not guaranteed to be 100 % but if to measles virus then the condition is not too severe. Immunization can be performed twice. First at the age of 9 months of age infants have been derived antibodies from the mother through the placenta had to decline so need additional antibodies through immunization. In order for the toddler immune better then repeated measles vaccination at age 15 months with MMR immunization (Measles, Mumps and Rubella).

2.9 Past Research

In this study the researcher conducted several studies on similar previous studies. The first study is The Analysis of Comparison of Expert System of Diagnosing Dog Disease by Certainty Factor and Dempster Shafer Method (Eka Setyarini, Darma Putra and Adi Purnawan, 2013). In this study, researcher made application using two methods, there are dempster shafer and certainty factor for diagnosing 17 types of dog diseases. The result of system is type of disease, value of dempster shafer and certainty factor. The paper presents 10 cases to comparing result between dempster shafer and certainty factor method. The conclusion shows that dempster shafer method is more accurate than certainty factor method [11].

The second study is Comparative Analysis Expert System for Diagnosing Oral and Dental Diseases in Humans using Certainty Factor and Dempster-Shafer Theory (Husain, 2010). In this study, researcher developed an application to diagnose type of oral and dental disease using dempster shafer and certainty factor method. These methods will be compared to know which method is better. This expert system testing using 50 patient medical history data owned drg. Sudarti. Based on these tests, the Dempster-Shafer theory is able to produce a higher level of accuracy than the approach of using Certainty Factor [12].

Application Expert System Development for Diagnosing Kidney Disease using Dempster Shafer (Rismawati, 2013). In this study, the researchers applied the dempster shafer method as a measure of the level of confidence against symptoms of disease. Deficiencies contain on this study is researchers have yet to

implement the results of research into the real application Expert systems with Dempster Shafer methods can be determining the percentage of symptoms based on the number of symptoms is entered [13].

The last study is Implementation Certainty Factor and Forward Chaining Method in Expert System for Diagnosing Toddler Infectious Diseases (Rizka Fajriah, 2014). In this study, the researchers applied the certainty factor method as a measure of the level of confidence against symptoms of disease. Deficiencies contain on this study is researchers have yet to implement the results of research into web based application. [14].

Table 2.1: Comparison of Journals

Journal Title	Problem	Research Metodhology	Result	Advantages	Disadvantages
The Analysis of Comparison of Expert System of Diagnosing Dog Disease by Certainty Factor Method and Dempster-Shafer Method (Eka Setyarini, Darma Putra and Adi Purnawan, 2013).	There are some dog diseases that spread in the environment. The dog will easily become infected if not vaccinate. If a dog has been infected with the disease then the owner should take it to a doctor, but in this case there is a constraint that is expensive and limited time owner.	1. Method of Certainty Factor (CF), to obtain a level of trust. The value to be used in this method is obtained from an expert. 2. Dempster Shafer method, which uses a two-stage method of obtaining the confidence level of experts then combine with each other to obtain the final result.	The result of the Dempster Shafer method is higher than the Certainty Factor method, but calculations using Certainty Factor method is easier to do.	The researcher has been developed application for dog diseases expert system, testing of application has been done by expert	Test of application only by one expert

Journal Title	Problem	Research Metodhology	Result	Advantages	Disadvantages
Comparative Analysis Expert System for Diagnosing Oral and Dental Diseases in Humans using Certainty Factor and Dempster-Shafer Theory (Husain, 2010).	Teeth and mouth are part of the body that must be maintained. However, people like careless and do not take good care so that arose diseases of the teeth and mouth. However, people sometimes underestimate to immediately check by a doctor because of the limited time and costs.	1. Method of Certainty Factor (CF), to obtain a level of trust. The value to be used in this method is obtained from an expert. 2. Dempster Shafer method, which uses a two-stage method of obtaining the confidence level of experts then combine with each other to obtain the final result.	The result of the Dempster Shafer method is higher than the Certainty Factor method, but calculations using Certainty Factor method is easier to do.	Testing of this expert system uses 50 patient's health history data that owned by drg. Sudarti. It's mean the application has good result.	-

Journal Title	Problem	Research Metodhology	Result	Advantages	Disadvantages
Application Expert System Development for Diagnosing Kidney Disease using Dempster Shafer (Rismawati, 2013).	Symptoms of the kidney disease is early emergence of a disease that can be life-threatening, ironically, these symptoms are often ignored by someone. The symptoms are not dangerous because it has little effect on the activity and considers these symptoms will go away by its. In addition, the high cost of treatment to be one of the causes of the	Dempster Shafer method, which uses a two-stage method of obtaining the confidence level of experts then combine with each other to obtain the final result.	Dempster Shafer methods can provide a level of confidence to the user in diagnosing kidney disease.	In the research, application has been developed for user who suffered kidney disease's symptoms.	The Researcher doesn't explain about data sources what come from expert or other.

	lack of public interest in went to the doctor.				
Implementation Certainty Factor and Forward Chaining Method In Expert System for Diagnosing Toddler Infectious Diseases (Rizka Fajriah, 2014).	Infectious disease is a disease that is easily infects children. There are a number of infectious diseases that could endanger the lives of patients. Parents should give more attention to this matter. However, the limited time and cost of making the parents become less rapid in action.	1. Method of Certainty Factor (CF), to obtain a level of trust. The value to be used in this method is obtained from an expert. 2. Forward Chaining as an inference engine which regulate the rules that have been made, of a group symptoms until it reaches a diseases	Certainty factor method is able to provide a level of trust for any disease diagnosed.	The research has been developed expert system web based which can make user easy to access.	The expert system only diagnosis eight diseases, the data obtained only from one expert.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Types of Research Data

The research data is the data will be used to support the way of research process, which data of this study has two types used namely the primary data and secondary data.

3.1.1 Primary Data

Primary data is the research data obtained directly from primary sources or do not through the mediator. Primary data can be subject opinion individually or group. In this study, the primary data source is obtained directly in the field of answers a pediatrician regarding infectious disease in toddlers.

3.1.2 Secondary Data

Secondary data is data or information obtained from other parties or indirectly. Secondary data can be a good record which has been published or not. Secondary data source to support this research was obtained from the literature on the subject related to the study.

3.2 Data Collection Method

Data collection techniques to support the process of this research are as follows:

1. Interview

   At this stage the researcher conducted interviews with pediatrician, dr. Piprim B. Yanuarso, Sp.A (K). At this stage the researcher asked several questions related to the research needs such as symptoms data and infectious diseases in toddlers with the certainty value of some symptoms in an illness. Informants can give value with a range 0 to 1 for each symptom for every disease. Scoring is based on the theory contained in the Certainty Factor and Dempster Shafer method which states if given value is 0 (zero), it indicates the absence of symptoms (evidence); if given value is 1, it indicates the presence of certainty [10].

2. Literature Study

   Data collection through literature study aims to explore as much information as possible about the objects and elements involved in this study. At this stage the literature study conducted by searching for information through e-books, articles, and journals.

3.3 Research Data Analysis

The data will be used in comparison of two methods is the value assigned by expert for each symptoms data in a disease. This value will be used as input data in the calculation process. Then, in the calculation process for each method

will produce an output data will be used as support in making decision. In this case the way to generate an output of the certainty factor method is different with dempster shafer method.

In this study contained 25 symptoms and 8 diseases data. List of symptoms that will be input for each method are shown in table 3.1.

Table 3.1: Decision Table

No	Symptoms	A	B	C	D	E	F	G	H
1	Spleen enlarges slightly	x							
2	Child has a rash (redness of skin) is flat, especially on the chest and abdomen and sometimes spreads to the face, arms and legs	x							
3	Can swelling of lymph nodes in the back of the head, neck next to the side and behind the ears	x							
4	Despite the high fever, but the child remained conscious and active	x							
5	When body temperature started to increase, 5-10% of patients experienced febrile seizures (seizures due to high fever)	x							
6	Fever	x	x		x			x	x
7	Respiratory disorders		x						
8	After passing 2 - 4 days, the rash spreads to the line of the body, arms and legs		x						
9	Rash (like a punch) on both cheeks		x						
10	There is a rash of small blisters containing			x					

	pus and scab around the face, hands, head								
11	After one or two days, appeared spots - red color and become blisters filled with water				x				
12	Sometimes breathing sounds when breathing or after coughing					x			
13	Flu/Cold					x	x		x
14	Persistent cough discontinuous and can choke or vomit					x			
15	Glands at the back of the neck will swell						x		
16	Speckled rash that appears within one or two days - first in the face, then the rest of the body						x		
17	Difficult to chew and swallow							x	
18	Headache							x	
19	Dry mouth							x	
20	The gland swollen and tender under the ears and under the chin							x	
21	White patches in the mouth (Koplik spots)								x
22	The rash appears on the third or fourth day								x
23	The spots will be flushed and more and more, but not itchy.								x
24	Coughing hard								x
25	Watery eyes, inflamed, red								x

Descriptions:

A : Roseola infatum

B : Red Cheek Syndrome (Parvovirus B19)

C : Impetigo

D : Chikenpox

E : Whooping Cough

F : Rubela (German Measles)

G : Mumps

H : Measles (rubeola, measles 9 days)

3.3.1 Range of Input Data

Each data that will be input in the calculation each method has a range more than 0 to 1. However, if data is not used as an input, then, regarded as a variable No and the value is 0.

Table 3.2: Range Value

Symptoms	Variable	Value
1. Spleen enlarges slightly 2. Child has a rash (redness of skin) is flat, especially on the chest and abdomen and sometimes spreads to the face, arms and legs 3. Can swelling of lymph nodes in the back of the head, neck next to the side and behind the ears 4. Despite the high fever, but the child remained conscious and active 5. When body temperature started to increase, 5-10% of patients experienced febrile seizures (seizures due to high fever) 6. Fever 7. Respiratory disorders 8. After passing 2 - 4 days, the rash spreads to the line of the body, arms and legs 9. Rash (like a punch) on both cheeks	Yes	0..1
10. There is a rash of small blisters containing pus and scab around the face, hands, head 11. After one or two days, appeared spots - red color and become blisters filled with water 12. Sometimes breathing sounds when breathing or after coughing 13. Flu/Cold 14. Persistent cough discontinuous and can choke or vomit 15. Glands at the back of the neck will swell	No	0

16. Speckled rash that appears within one or two days - first in the face, then the rest of the body 17. Difficult to chew and swallow 18. Headache 19. Dry mouth 20. The gland swollen and tender under the ears and under the chin 21. White patches in mouth 22. The rash appears on the third or fourth day 23. The spots will be flushed and more and more, but not itchy 24. Coughing hard 25. Watery eyes, inflamed, red		

3.3.2 Output of Certainty Factor Method

Output data of certainty factor method obtained through calculation result CF value every symptom selected then conducted a comparative analysis of the certainty factor final value from several possible diseases which can occur. The highest CF value will be used as the final decision on the method

For example symptoms were selected for case 1 is symptom no 1, 2, 3, 4, 5, 6, and 7 then the possibility of disease suffered is disease A, B, D, H. Because the symptoms selected most is symptom of disease A (no 1, 2, 3, 4, 5, 6), then the possible CF value on disease A larger than disease B, D, H which only have symptom no 7.

In table 3.3 shown some examples the output data acquisition of certainty factor method:

Table 3.3: Description Output of Certainty Factor Method

Case	Formula	Result
1	CF(A) > CF(B) > CF(D) > CF(H)	A
2	CF(B) > CF(A) > CF(D) > CF(G) > CF(H)	B
3	CF(E) > CF(F) > CF(H)	E
4	CF(H) > CF(F) > CF(E)	H

3.3.3 Output of Dempster Shafer Method

Output data of Dempster Shafer method obtained through calculation results density values every symptom selected then conducted a comparative analysis the mass function final value of several possible diseases which can occur. The highest mass function value will be used as final decision on the method.

For example symptoms were selected for case 1 is symptom no 1, 2, 3, 4, 5, 6, and 7 then the possibility of disease suffered is disease A, B, D, H and G. Because the symptoms selected most is symptom of disease A (no 1, 2, 3, 4, 5, 6), then the possible mass function value on disease A higher than disease B, D, H, G which only have symptom no 7.

Table 3.4 shows some examples the output data acquisition of dempster shafer metho

Table 3.4: Description Output of Dempster Shafer Method

Case	Formula	Result
1	m(A) > m(ABDHG) > m(Θ)	A
2	m(F) > m(F,H,E) > m(Θ)	F
3	m(D) > m(A,D,H,B,G) > m(Θ)	D
4	m(E) > m(E,H,F) > m(Θ)	E

3.4 Research Methodology

Stages that must conducted before making a comparative analysis is the calculation stage for every method with the same variable or input. In this stage will be shown how calculate the confidence value for every method which will be used as output by the system. Each of these methods has different calculations technique, but do not close possibility that the results will be issued not far adrift with each other. Figure 3.1 shows the stages in the process of doing a comparison between Certainty Factor and Dempster Shafer method.

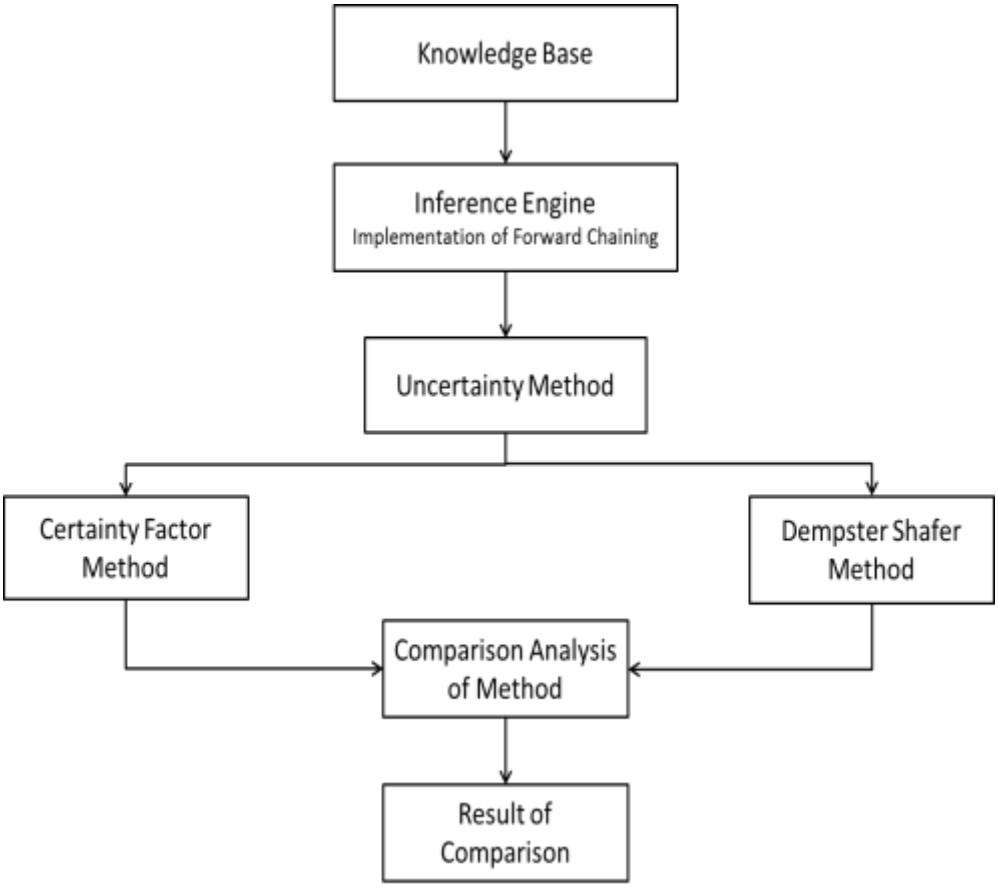

Figure 3.1 . Methodology of Comparative Analysis for Certainty Factor and Dempster Shafer Method

3.4.1 Make Knowledge Base

The first step in this comparative analysis is building a knowledge base. The knowledge base contains the knowledge for understanding, formulation, and problem solving [3]. Knowledge that can be derived from the experts, books, databases, research and images.

There are two forms of approach to knowledge base:

- Rule-based Reasoning

  In the rule-based reasoning, knowledge is represented using IF-THEN rules of the form. This form is used when we have a number of expert knowledge on a particular issue, and the expert can solve the problem sequentially. In addition, this form is also used when needed explanation of the trail (the steps) the achievement of a solution.

- Case-based Reasoning

  In case-based reasoning, knowledge base will contain solutions that have been achieved previously, then lowered a solution to the current situation (the facts). This form is used when the user wants to know more on the cases are almost the same (similar). In addition, this form is used when we have had a number of situations or specific cases in the knowledge base.

3.4.2 Determine Inference Engine

In establishing an expert system, researchers must determine the appropriate model of reasoning to the case that will be made. There are two models of reasoning in expert systems namely [3]:

- Forward Chaining: matching a fact or statement of facts first started to test the truth of the hypothesis. Suitable inference method is used to deal with control problems and forecasting.

- Backward Chaining: matching facts or statements starting from the first hypothesis, and to test the truth of this hypothesis to look for the facts that exist in the knowledge base. Workplace / Blackboard

Reasoning models will be used by researcher is Forward Chaining approach, reasoning which can conduct described is as follow:

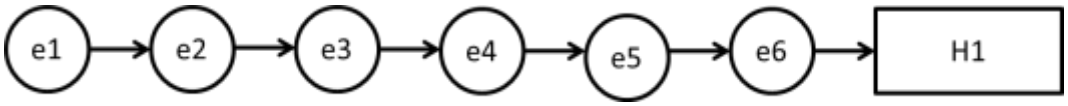

Figure 3.2: Model of Forward Chaining

The figure 3.2 contained 6 evidences namely symptom 1 until 6, then contained hypothesis 1 as a disease that may occur. The figure shows that Forward Chaining method will adjust first symptoms after that will be directed where the disease is more suitable and more likely based on the symptoms selected.

3.4.3 Implementation of Uncertainty Method

The next step is implement method or approach used to calculate values of facts contained in the knowledge base. In this study, will used two methods namely Certainty Factor and Dempster Shafer method. Each method has a different calculation. The following are the steps in the process of calculation to be performed.

3.4.3.1 The Steps of Certainty Factor Method Calculation

In performing calculations using Certainty Factor there are several stages. The flow of calculation CF value for symptoms selected as follows:

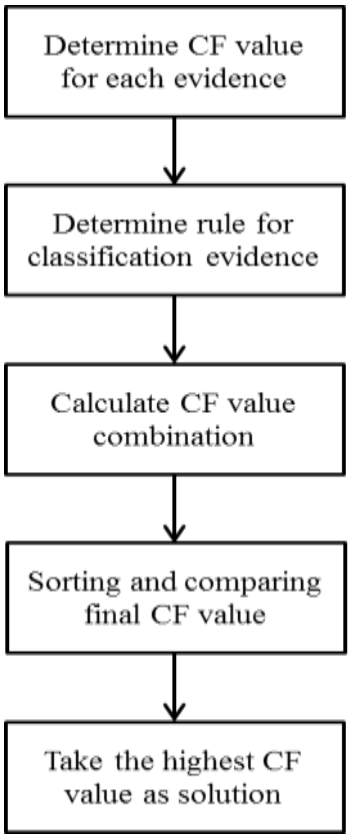

Figure 3.3: Steps of Certainty Factor Method Calculation

1. Determine CF Value for each evidence

   In calculating the value of confidence with Certainty factor method, the first step is to determine the CF value for every fact or evidence which derived from the results of interviews with experts. Specialists can provide a value from 0 to 1 for each fact in against a hypothesis.

2. Determine rule for classification evidence

   The next step is to determine the rules for direct line of reasoning a hypothesis. In this case contains the rules of the facts that classified for each hypothesis.

3. Calculate CF Value Combination

   The third step is to calculate the CF values with equation CF Combination. This calculation process can be done by combining each selected fact which is also the fact of hypotheses that may occur.

4. Sorting and comparing final CF Value

   After completing the calculation, the result value of some hypotheses can be sorted from largest to smallest. Then compare the value of each hypothesis.

5. Take the highest CF value as solution

   The final step is to take the largest CF value on a hypothesis to be used as the final result or solution of the cases.

3.4.3.2 The Steps of Dempster Shafer Method Calculation

In performing calculations using Dempster Shafer there are several stages. The flow of calculation CF value for symptoms selected as follows:

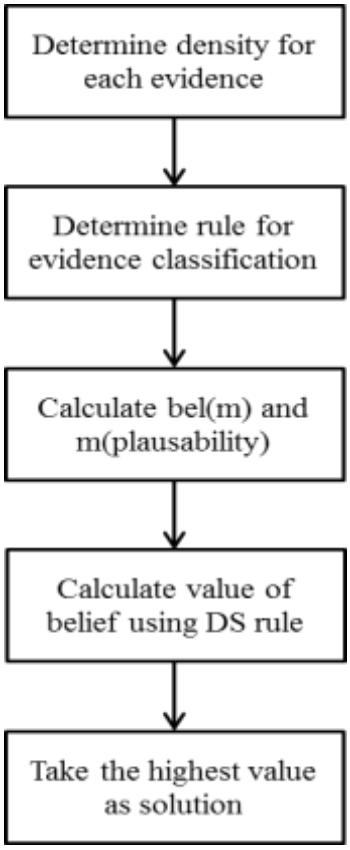

Figure 3.4: Steps of Dempster Shafer Method Calculation

1. Determine density for each evidence

   In calculating the value of confidence with Dempster Shafer method, the first step is to determine the density for every fact or evidence which derived from the results of interviews with experts. Specialists can provide a value from 0 to 1 for each fact in against a hypothesis.

2. Determine rule for classification evidence

   The next step is to determine the rules for direct line of reasoning a hypothesis. In this case contains the rules of the facts that classified for each hypothesis.

3. Calculate bel (m) and m(plausibility)

   The third step is to calculate bel (m) and m(plausibility). Bel(m) is density for each evidence, whereas the m(plausibility) obtained by equation 1-bel(m).

4. Calculate value of belief with Dempster's Rule Combination

   The next step is to calculate bel(m) and m(plausibility) with equation Dempster's rule combination. This calculation process can be done by combining each selected fact which is also the fact of hypotheses that may occur.

5. Take the highest value as solution

   The final step is to take the highest value of some hypothesis to be used as the final result or solution of the cases.

3.4.4 Comparison Analysis of Method

The next step after implement calculation method is do a comparison for every results issued from each methods. Then, the results will be analyzed to determine which method is more accurate and better used. The comparison is not only done manually by looking at the end result of every calculation, but researcher will compare the results using the Decision Support System applications. It can be a support for the results of comparative analysis method.

3.4.5 Result of Comparison

The results of comparison method will be made in form table containing results of calculation for every case in every method, weighting alternative, weighting criteria, alternative ranking, alternative Main Criteria Matrix which is result of Open Decision Maker application.

CHAPTER IV

ANALYSIS AND RESULT

4.1 Calculation Techniques with Certainty Factor Method

The first step to calculate the trust value by using Certainty Factor is initializing symptoms contained in the knowledge base. These symptoms will be used as input followed by classifying the symptoms and determine the rules are suitable for the chosen symptoms to obtain required results. Initialize the symptoms will be named using symptoms code. List of initialization symptoms contained in the knowledge base can be seen in table 4.1:

Table 4.1: Symptom Initialization

Code	Symptoms
A001	Spleen enlarges slightly
A002	Child has a rash (redness of skin) is flat, especially on the chest and abdomen and sometimes spreads to the face, arms and legs
A003	Can swelling of lymph nodes in the back of the head, neck next to the side and behind the ears
A004	Despite the high fever, but the child remained conscious and active
A005	When body temperature started to increase, 5-10% of patients experienced febrile seizures (seizures due to high fever)
A006	Fever
B001	Respiratory disorders
B002	After passing 2 - 4 days, the rash spreads to the line of the body,

	arms and legs
B003	Rash (like a punch) on both cheeks
C001	There is a rash of small blisters containing pus and scab around the face, hands, head
D001	After one or two days, appeared spots - red color and become blisters filled with water
E001	Sometimes breathing sounds when breathing or after coughing
E002	Flu/Cold
E003	Persistent cough discontinuous and can choke or vomit
F001	Glands at the back of the neck will swell
F002	Speckled rash that appears within one or two days - first in the face, then the rest of the body
G001	The gland swollen and tender under the ears and under the chin
G002	Dry mouth
G003	Headache
G004	Difficult to chew and swallow
H002	White patches in the mouth (Koplik spots)
H003	The rash appears on the third or fourth day
H004	The spots will be flushed and more and more, but not itchy.
H005	Coughing hard
H007	Watery eyes, inflamed, red

The next step is determining CF value for every symptom in every disease. This value is determined by an expert or a pediatrician. Table 4.2 show the CF values which given by experts to give a solution.

Table 4.2: CF Value of Symptoms

Code	CF Value	Code	CF Value
A001	0.1	E003	0.8
A002	0.7	F001	0.7
A003	0.6	F002	0.8
A004	0.5	G001	0.6
A005	0.4	G002	0.8
A006	0.8	G003	0.5
B001	0.5	G004	0.8
B002	0.4	H002	0.5
B003	0.1	H003	0.8
C001	0.7	H004	0.7
D001	0.8	H005	0.7
E001	0.6	H007	0.8
E002	0.7		

After determining the CF values for every symptom, the next process is calculate the values with CF combination equation as follow:

$$CF(R1,R2) = CF(R1) + CF(R2) - [\ (CF(R1) \times CF(R2)\ ] \quad \text{……..(1)}$$

Or

$$CF(R1,R2) = CF(R1) + CF(R2) * [1-CF(R1)] \quad \text{..…….(2)}$$

Calculation for the selected symptoms are classified based on rule that has been created, which each rule will be calculated the certainty value so that will be

obtained the highest CF value of comparison results would be the solution. Here is example the calculation of Certainty Factor:

Table 4.3 describes the symptoms selected. On the table contained code of symptoms, symptoms name and CF values at every symptom.

Table 4.3: Symptom Selected

Code	**Symptoms**	**CF Value**
A001	Spleen enlarges slightly	0.1
A002	Child has a rash (redness of skin) is flat, especially on the chest and abdomen and sometimes spreads to the face, arms and legs	0.7
A003	Can swelling of lymph nodes in the back of the head, neck next to the side and behind the ears	0.6
A004	Despite the high fever, but the child remained conscious and active	0.4
A005	When body temperature started to increase, 5-10% of patients experienced febrile seizures (seizures due to high fever)	0.4
A006	Fever	0.8
B002	After passing 2 - 4 days, the rash spreads to the line of the body, arms and legs	0.4
E001	Sometimes breathing sounds when breathing or after coughing	0.6
E002	Flu/Cold	0.7
G003	Headache	0.5
H002	White patches in the mouth (Coplic spots)	0.5
H004	The spots will be flushed and more and more, but not itchy.	0.7

H005	Coughing hard	0.7

Symptoms are selected will be classified into several rules based on the code of disease which may be suffered. The classification can be seen in table 4.4.

Table 4.4: Classification Symptom into Rule

Disease Code	**Symptom Code**	**CF Value**
A	A001	0.1
A	A002	0.7
A	A003	0.6
A	A004	0.4
A	A005	0.4
A	A006	0.8
B	B002	0.4
B	A006	0.6
D	A006	0.8
E	E001	0.7
E	E002	0.5
G	G003	0.5
G	A006	0.8
H	H002	0.7
H	A006	0.8
H	H004	0.7
H	E002	0.5

After classifying these symptoms, then the calculation process can be conducted. From the symptoms classification contained 6 possible diseases can suffered,

namely disease A, B, D, E, G and H. The calculation will be conducted for every diseases rule as follow:

The first stage is to calculate the first rule of the results of symptoms classification. Preliminary calculations is to involve the CF values for evidence 1 (e1) and evidence 2 (e2), then the results will be combined with subsequent evidence until all the evidence in the rule is calculated. Here are the results of calculations for every disease that selected based on symptoms

Disease A:

CF(A1) = CF(A001) + CF(A002) * [1-CF(A001)] = 0,1 + 0,7* [1 – 0,1]

= 0,73 ……..(2)

CF(A2) = CF(A003) + CF(A1) * [1-CF(A003)] = 0,6+ 0,73 * [1 – 0,6]

= 0,892 ……..(2)

CF(A3) = CF(A004) + CF(A2) * [1-CF(A004)] = 0,4 + 0,892* [1 – 0,4]

= 0,935 ……..(2)

CF(A4) = CF(A005) + CF(A3) * [1-CF(A005)] = 0,4+ 0,935 * [1 – 0,4]

= 0,961 ……..(2)

CF(A5) = CF(A006) + CF(A4) * [1-CF(A006)] = 0,8+ 0,961 * [1 – 0,8]

= 0,9922 ……..(2)

Based on the above calculation using the combination equation of Certainty Factor method, the final results are obtained for disease A is 0.9922.

Disease B:

CF(B) = CF(B002) + CF(A006) * [1-CF(B001)] = 0,4 + 0,8* [1 – 0,4]

= 0,88 ……..(2)

Based on the above calculation using the combination equation of Certainty Factor method, the final results are obtained for disease B is 0.88.

Disease D:

CF(D) = 0.8

Disease D can not calculated using combination equation because only contained an evidences. So, the CF value of disease D in this case is 0.8.

Disease E:

CF(E) = CF(E001) + CF(E002) * [1-CF(E001)] = 0,7 + 0,5* [1 – 0,7]

= 0,85 ……..(2)

Based on the above calculation using the combination equation of Certainty Factor method, the final results are obtained for disease E is 0.85.

Disease G:

CF(G) = CF(G003) + CF(A006) * [1-CF(G003)] = 0,5 + 0,8* [1 – 0,5]

= 0,9 ……..(2)

Based on the above calculation using the combination equation of Certainty Factor method, the final results are obtained for disease G is 0.9.

Disease H:

CF(H1) = CF(H002) + CF(A006) * [1-CF(H002)] = 0,7 + 0,8* [1 – 0,7]

= 0,94 ……..(2)

CF(H2) = CF(H004) + CF(H1) * [1-CF(H004)] = 0,7+ 0,94 * [1 – 0,7]

= 0,982 ……..(2)

CF(H3) = CF(E002) + CF(H2) * [1-CF(E002)] = 0,5 + 0,982* [1 – 0,5]

= 0,991 ……..(2)

Based on the above calculation using the combination equation of Certainty Factor method, the final results are obtained for disease H is 0.991.

Based on calculations for the fifth hypothesis above it can be compared the final CF value of every disease namely CF(A) > CF(H) > CF(G) > CF(B) > CF(E) > CF(D). The CF value for disease A is the highest value, it is 0.9922. It can be concluded that disease suffered is disease A with a confidence level is 0.9922 or 99.22%.

Example calculation for the second case can be seen as follows:

The symptoms selected are: A006, H002, H003, H004, H005, H006 and H007. Then these symptoms will be classified into disease A, B, D, G and H. Value for A006 is 0.8, H002 is 0.5, H003 is 0.8, H004 is 0.7, H005 is 0.7, H006 is 0.7 and H007 is 0.8. Then the value on any evidence contained in H disease can be calculated using the formula CF combination as follows:

CF(H1) = CF(A006) + CF(H002) * [1-CF(H001)] = 0,8 + 0,5* [1 – 0,8]

= 0,9 ……..(2)

CF(H2) = CF(H003) + CF(H1) * [1-CF(H003)] = 0,8+ 0,9 * [1 – 0,8]

= 0,98 ……..(2)

CF(H3) = CF(H004) + CF(H2) * [1-CF(H004)] = 0,7 + 0,98* [1 – 0,7]

= 0,994 ……..(2)

CF(H4) = CF(H005) + CF(H3) * [1-CF(H005)] = 0,7+ 0,994 * [1 – 0,7]

= 0,9982 ……..(2)

CF(H5) = CF(E006) + CF(H4) * [1-CF(E006)] = 0,7+ 0,9982 * [1 – 0,7]

= 0,99946 ……..(2)

CF(H7) = CF(H007) + CF(H4) * [1-CF(H007)] = 0,8+ 0,99946 * [1 – 0,8]

= 0,99989 ……..(2)

Based on the above calculation using the combination equation in Certainty Factor method, final results are obtained for H disease is 0.99989. Whereas for the CF value on disease A, B, D and G is 0.8, because there is only one selected evidence on the disease that is evidence A006. So that the final result is disease H with CF value 0.99989. The calculation for others case using Certainty Factor method will be explained in appendix 1.

4.2 Calculation Techniques with Dempster Shafer Method

In the process of calculating of the trust value by using Dempster Shafer, the stage is initializing the symptoms that are contained in knowledge base. These symptoms will be used as input then performed symptoms classification based on diseases which have a relationship with these symptoms. Below is a table initialization symptoms contained in the knowledge base.

Table 4.5: Symptom Initialization

Code	Symptoms
A001	Spleen enlarges slightly
A002	Child has a rash (redness of skin) is flat, especially on the chest and abdomen and sometimes spreads to the face, arms and legs
A003	Can swelling of lymph nodes in the back of the head, neck next to the side and behind the ears
A004	Despite the high fever, but the child remained conscious and active
A005	When body temperature started to increase, 5-10% of patients experienced febrile seizures (seizures due to high fever)
A006	Fever
B001	Respiratory disorders
B002	After passing 2 - 4 days, the rash spreads to the line of the body, arms and legs
B003	Rash (like a punch) on both cheeks
C001	There is a rash of small blisters containing pus and scab around the face, hands, head
D001	After one or two days, appeared spots - red color and become blisters filled with water

E001	Sometimes breathing sounds when breathing or after coughing
E002	Flu/Cold
E003	Persistent cough discontinuous and can choke or vomit
F001	Glands at the back of the neck will swell
F002	Speckled rash that appears within one or two days - first in the face, then the rest of the body
G001	The gland swollen and tender under the ears and under the chin
G002	Dry mouth
G003	Headache
G004	Difficult to chew and swallow
H002	White patches in the mouth (Koplik spots)
H003	The rash appears on the third or fourth day
H004	The spots will be flushed and more and more, but not itchy.
H005	Coughing hard
H007	Watery eyes, inflamed, red

The next step is determining CF value for every symptom in every disease. This value is determined by an expert or a pediatrician. Table 4.2 show the CF values which given by experts to give a solution.

Table 4.6: Density Value of Symptoms

Code	**CF Value**	**Code**	**CF Value**
A001	0.1	E003	0.8
A002	0.7	F001	0.7
A003	0.6	F002	0.8
A004	0.5	G001	0.6
A005	0.4	G002	0.8

A006	0.8	G003	0.5
B001	0.5	G004	0.8
B002	0.4	H002	0.5
B003	0.1	H003	0.8
C001	0.7	H004	0.7
D001	0.8	H005	0.7
E001	0.6	H007	0.8
E002	0.7		

After determining the dencity values for every symptom, the next process is calculate the values with equation as follow:

$$Bel(X) = \sum_{Y \subseteq X} m(Y) \qquad \text{……(3)}$$

While Plausibility (Pls) is denoted as:

$$Pls(X) = 1 - Bel(X') = 1 - \sum_{Y \subseteq X} m(X') \qquad \text{……..(4)}$$

Where:

Bel(X) = Belief (X)

Pls(X) = Plausibility (X)

M(X) = mass function of (X)

m(Y) = mass function of (Y)

$$m1 \oplus m2(Z) = \frac{\sum_{X \cap Y = Z} m1(X) m2(Y)}{1 - \sum_{X \cap Y = \theta} m1(X) m2(Y)}. \qquad \text{……..(5)}$$

Where:

m1⊕ m2(Z) = mass function of evidence (Z)

m1(X) = mass function of evidence (X)

m2(Y) = mass function of evidence (Y)

In the calculation of Dempster Shafer methods, all symptom selected will be calculated of certainty and uncertainty value. The symptoms are matched by rule contained in knowledge base, there will be the possibility of groupings disease occur based on selected symptoms. Then be calculated each belief value any additional facts or new symptoms by means of combining them. Thus, will be resulted the highest confidence value that will serve as a solution. Here is an example the calculation of Dempster Shafer method:

Table 4.7 describes the symptoms selected. On the table contained code of symptoms, symptoms name and density values at every symptom.

Table 4.7: Symptom Selected

Code	**Symptoms**	**Density Value**
A001	Spleen enlarges slightly	0.1
A002	Child has a rash (redness of skin) is flat, especially on the chest and abdomen and sometimes spreads to the face, arms and legs	0.7
A003	Can swelling of lymph nodes in the back of the head, neck next to the side and behind the ears	0.6
A004	Despite the high fever, but the child remained conscious and	0.4

	active	
A005	When body temperature started to increase, 5-10% of patients experienced febrile seizures (seizures due to high fever)	0.4
A006	Fever	0.8
B002	After passing 2 - 4 days, the rash spreads to the line of the body, arms and legs	0.4
E001	Sometimes breathing sounds when breathing or after coughing	0.6
E002	Flu/Cold	0.7
G003	Dry mouth	0.5
H002	White patches in the mouth (Koplik spots)	0.5
H004	The spots will be flushed and more and more, but not itchy.	0.7
H005	Coughing hard	0.7

Symptoms are selected will be classified into several rules based on the code of disease which may be suffered. The classification can be seen in table 4.8.

Table 4.8: Classification Symptom into Rule

Disease Code	**Symptom Code**	**Density Value**
A	A001	0.1
A	A002	0.7
A	A003	0.6
A	A004	0.4
A	A005	0.4
A	A006	0.8
B	B002	0.4

B	A006	0.6
E	E001	0.7
E	E002	0.5
G	G003	0.5
G	A006	0.8
H	H002	0.7
H	A006	0.8
H	H004	0.7
E	E002	0.5

After classifying these symptoms, then the calculation process can be done. The whole symptoms will be tried in any combination. The calculation will be performed for each diseases rule as follows:

Known:

$\theta = \{A, B, D, E, G, H\}$

In this case there is evidence e1 being support the hypothesis for disease A with m = 0.1, which can be written as follows:

A001 = A

m1(A) = 0.1

m1(θ) = 1-0.1 = 0.9 ……..(3)

Then there is evidence e2 supporting the hypothesis for disease A with m = 0.7, which can be written as follows:

A002 = A

m2(A) = 0.7

m2(θ) = 1-0.7 = 0.3

First, combine the first symptoms (e1) and the second symptoms (e2) using equation Dempster's Rule of Combination to obtain a new value m which is shown as follows:

Table 4.9: Combination e1 and e2

	(A) 0.7	θ 0.3
(A) 0.1	(A) 0.07	(A) 0.03
θ 0.9	(A) 0.63	⊕ 0.27

By use of the Dempster rule then obtained value for m3 as follows:

M3(A) = 0.73

M3(θ) = 0.27

Then, combine the value of m3 with evidence e3 which supports the hypothesis A with a value of m = 0.6, can be written as follows:

A003 = A

M4(A) = 0.6

M4(θ) = 0.4

Combine using equation Dempater's Rule of Combination to obtain new m5 value is shown as follows:

Table 4.10: Combination with e3

	(A) 0.73	θ 0.27
(A) 0.6	(A) 0.438	(A) 0.162
θ 0.4	(A) 0.292	⊕ 0.108

By use of the Dempster rule then obtained value for m5 as follows:

M5(A) = 0.892

M5(θ) = 0.108

Then, combine the value of m5 with evidence e4 which supports the hypothesis A with a value of m = 0.4, can be written as follows:

A004 = A

M6(A) = 0.4

M6(θ) = 0.6

Combine using equation Dempater's Rule of Combination to obtain new m7 value is shown as follows:

Table 4.11: Combination with e4

	(A) 0.4	θ 0.6
(A) 0.892	(A) 0.3568	(A) 0.5352
θ 0.108	(A) 0.0432	⊕ 0.0648

By use of the Dempster rule then obtained value for m7 as follows:

M7(A) = 0.3568+0.5352+0.0432/(1-0) = 0.9352 ……..(5)

M7(θ) = 0.0684/(1-0) = 0.0684 ……..(5)

Then, combine the value of m7 with evidence e5 which supports the hypothesis A with a value of m = 0.4, can be written as follows:

A005 = A

M8(A) = 0.4

M8(θ) = 0.6

Combine using equation Dempater's Rule of Combination to obtain new m9 value is shown as follows:

Table 4.12: Combination with e5

	(A) 0.4	θ 0.6
(A) 0.9352	(A) 0.37408	(A) 0.56112
θ 0.0648	(A) 0.02592	⊕ 0.03888

By use of the Dempster rule then obtained value for m9 as follows:

M9(A) = 0.37408+0.56112+0.02592/(1-0) = 0.96112 ……..(5)

M9(θ) = 0.03888/(1-0) = 0.03888 ……..(5)

Then, combine the value of m9 with evidence e6 which supports the hypothesis A,B,D,G,H with a value of m = 0.8, can be written as follows:

A006 = A,B,D,G,H

M10(A,B,D,G,H)= 0.8

M10(θ) = 0.2

Combine using equation Dempater's Rule of Combination to obtain new m11 value is shown as follows:

Table 4.13: Combination with e6

	(ABDGH) 0.8	θ 0.2
(A) 0.96112	(A) 0.768896	(A) 0.192224
θ 0.03888	(ABDGH) 0.031104	⊕ 0.007776

By use of the Dempster rule then obtained value for m11 as follows:

M11(A) = 0.768896+0.192224/(1-0) = 0.96112 ……..(5)

M11(A,B,D,G,H)= 0.031104/(1-0) = 0.031104 ……..(5)

M11(θ) = 0.007776/(1-0) = 0.007776 ……..(5)

Then, combine the value of m10 with evidence e7 which supports the hypothesis B with a value of m = 0.4, can be written as follows:

B002 = B

M12(B) = 0.4

M12(θ) = 0.6

Combine using equation Dempater's Rule of Combination to obtain new m13 value is shown as follows:

Table 4.14: Combination with e7

	(A) 0.96112	(ABDGH) 0.031104	θ 0.007776
(B) 0.4	∅ 0.384448	(B) 0.0124416	(B) 0.00311
θ 0.6	(A) 0.576672	(ABDGH) 0.0186624	⊕ 0.004666

By use of the Dempster rule then obtained value for m13 as follows:

M13(A) = 0.576672/(1-0.384448) = 0.9368372 ……..(5)

M13(B) = 0.0124416+0.00311/(1-0.384448) = 0.0174946 ……..(5)

M13(ABDGH)0.0186624/(1-0.384448) = 0.0303182 ……..(5)

M13(θ) = 0.004666/(1-0.384448) = 0.0075795 ……..(5)

Then, combine the value of m13 with evidence e8 which supports the hypothesis E with a value of m = 0.7, can be written as follows:

E001 = E

M14(E) = 0.7

M14(θ) = 0.3

Combine using equation Dempater's Rule of Combination to obtain new m15 value is shown as follows:

Table 4.15: Combination with e8

	(A) 0.936837	(B) 0.017495	(ABDGH) 0.03032	θ 0.00758
€ 0.7	∅ 0.655786	∅ 0.012246	∅ 0.02122	€ 0.00531
θ 0.3	(A) 0.281051	(B) 0.005248	(ABDGH) 0.0091	⊕ 0.00227

By use of the Dempster rule then obtained value for m15 as follows:

M15(A) = 0.281051/(1-(0.655786+0.012246+0.02122) = 0.904443……..(5)

M15(B) = 0.005248/(1-(0.655786+0.012246+0.02122) = 0.01689..……..(5)

M15(A,B,D,G,H)=0.0091/(1-(0.655786+0.012246+0.02122) = 0.02927……..(5)

M15(E) = 0.00531/(1-(0.655786+0.012246+0.02122) = 0.017074……..(5)

M15(θ) = 0.00227/(1-(0.655786+0.012246+0.02122) = 0.007317……...(5)

Then, combine the value of m15 with evidence e9 which supports the hypothesis E with a value of m = 0.5, can be written as follows:

E002 = E

M16(E) = 0.5

M16(θ) = 0.5

Combine using equation Dempater's Rule of Combination to obtain new m17 value is shown as follows:

Table 4.16: Combination with e9

	(A) 0.904443	(B) 0.01689	(ABDGH) 0.02927	(E) 0.01707	θ 0.00732
(E,H) 0.5	∅ 0.452221	∅ 0.008445	∅ 0.01463	(E) 0.00854	(E,H) 0.00366
θ 0.5	(A) 0.452221	(B) 0.008445	(ABDGH) 0.01463	(E) 0.00854	⊕ 0.00366

By use of the Dempster rule then obtained value for m17 as follows:

M17(A) = 0.452221/(1-(0.452221+0.008445+0.01463) = 0.861869……..(5)

M17(B) = 0.008445/(1-(0.452221+0.008445+0.01463)

= 0.016095 ……..(5)

M17(A,B,D,G,H)= 0.01463/(1-(0.452221+0.008445+0.01463)

= 0.027892 ……..(5)

M17(E) = 0.00854+0.00854/(1-(0.452221+0.008445+0.01463)

= 0.024807 ……..(5)

M17(E,H) = 0.00366/(1-(0.452221+0.008445+0.01463)

= 0.006973 ……..(5)

M17(θ) = 0.00227/(1-(0.452221+0.008445+0.01463)

= 0.006973 ……..(5)

Then, combine the value of m17 with evidence e10 which supports the hypothesis G with a value of m = 0.5, can be written as follows:

G003 = G

M18(G) = 0.5

M18(θ) = 0.5

Combine using equation Dempater's Rule of Combination to obtain new m19 value is shown as follows:

Table 4.17: Combination with e10

	(A) 0.861869	(B) 0.016095	(ABDGH) 0.02789	(E) 0.02481	(E,H) 0.00697	θ 0.00697
(G) 0.5	∅ 0.430934	∅ 0.008047	(G) 0.01395	∅ 0.0124	∅ 0.00349	(G) 0.00349
θ 0.5	(A) 0.430934	(B) 0.008047	(ABDGH) 0.01395	(E) 0.0124	(E,H) 0.00349	⊕ 0.00349

By use of the Dempster rule then obtained value for m19 as follows:

M19(A) = 0.430934/(1-(0.430934+0.008047+0.0124+0.00349)

= 0.790519 ……..(5)

M19(B) = 0.008047/(1-(0.430934+0.008047+0.0124+0.00349)

= 0.014762 ……..(5)

M19(A,B,D,G,H)=0.01395/(1-(0.430934+0.008047+0.0124+0.00349)

= 0.025583 ……..(5)

M19(E) = 0.0124/(1-(0.430934+0.008047+0.0124+0.00349)

= 0.022754 ……..(5)

M19(E,H) = 0.00349/(1-(0.430934+0.008047+0.0124+0.00349)

= 0.006396 ……..(5)

M19(G) = 0.01395+0.00349/(1-(0.430934+0.008047+0.0124+0.00349)

= 0.020342 ……..(5)

M19(θ) = 0.00227/(1-(0.430934+0.008047+0.0124+0.00349)

= 0.0063 ……..(5)

Then, combine the value of m19 with evidence e11 which supports the hypothesis H with a value of m = 0.7, can be written as follows:

H002 = H

M20(H) = 0.7

M20(θ) = 0.3

Combine using equation Dempater's Rule of Combination to obtain new m21 value is shown as follows:

Table 4.18: Combination with e11

	(A) 0.790519	(B) 0.014762	(ABDGH) 0.02558	(E) 0.02275	(E,H) 0.0064	(G) 0.02034	θ 0.0064
(H) 0.7	∅ 0.553364	∅ 0.010334	(H) 0.01791	∅ 0.01593	(H) 0.00448	∅ 0.01424	(H) 0.00448
θ 0.3	(A) 0.237156	(B) 0.004429	(ABDGH) 0.00767	(E) 0.00683	(E,H) 0.00192	(G) 0.0061	⊕ 0.00192

By use of the Dempster rule then obtained value for m21 as follows:

M21(A) = 0.237156/(1-(0.553364+0.010334+0.01593+0.01424)

= 0.58932 …….. (5)

M21(B) = 0.004429/(1-(0.553364+0.010334+0.01593+0.01424)

= 0.010904 …….. (5)

M21(A,B,D,G,H)=0.00767/(1-(0.553364+0.010334+0.01593+0.01424)

= 0.018897 …….. (5)

M21(E) = 0.00683/(1-(0.553364+0.010334+0.01593+0.01424)

= 0.016807 …….. (5)

M21(E,H) = 0.00192/(1-(0.553364+0.010334+0.01593+0.01424)

= 0.004724 …….. (5)

M21(G) = 0.0061/(1-(0.553364+0.010334+0.01593+0.01424)

= 0.015026 …….. (5)

M21(H) = 0.01791+0.00448+0.00448/(1-(0.553364+0.010334+0.01593

+0.01424) = 0.033409 …….. (5)

M21(θ) = 0.00192/(1-(0.553364+0.010334+0.01593+0.01424)

= 0.004724 …….. (5)

Then, combine the value of m21 with evidence e12 which supports the hypothesis H with a value of m = 0.7, can be written as follows:

H004 = H

M22(H) = 0.7

M22(θ) = 0.3

Combine using equation Dempater's Rule of Combination to obtain new m23 value is shown as follows:

Table 4.19: Combination with e12

	(A) 0.583932	(B) 0.010904	(ABDGH) 0.0189	(E) 0.01681	(E,H) 0.00472	(G) 0.01503	(H) 0.03341	θ 0.00472
(H) 0.7	∅ 0.408752	∅ 0.007633	(H) 0.01323	∅ 0.01177	(H) 0.00331	∅ 0.01052	(H) 0.02339	(H) 0.00331
Θ 0.3	(A) 0.17518	(B) 0.003271	(ABDGH) 0.00567	(E) 0.00504	(E,H) 0.00142	(G) 0.00451	(H) 0.01002	⊕ 0.00142

By use of the Dempster rule then obtained value for m23 as follows:

M23(A) = 0.17518/(1-(0.408752+0.007633+0.01177+0.01052)

= 0.312079 …….. (5)

M23(B) = 0.003271/(1-(0.408752+0.007633+0.01177+0.01052)

= 0.005828 …….. (5)

M23(A,B,D,G,H)= 0.00567/(1-(0.408752+0.007633+0.01177+0.01052)

= 0.0101 …….. (5)

M23(E) = 0.00504/(1-(0.408752+0.007633+0.01177+0.01052)

= 0.008983 …….. (5)

M23(E,H) = 0.00142/(1-(0.408752+0.007633+0.01177+0.01052)

= 0.002525 …….. (5)

M23(G) = 0.00451/(1-(0.408752+0.007633+0.01177+0.01052)

= 0.0803 …….. (5)

M23(H) = 0.01323+0.00331+0.02339+0.00331+0.01002/(1-(0.408752+

0.007633+0.01177+0.01052) = 0.0161083 …….. (5)

M23(θ) = 0.00142/(1-(0.408752+0.007633+0.01177+0.01052)

= 0.002525 …….. (5)

Based on the calculation above can be compared to the value of m for every possible disease namely m23(A) > m23(H) > m23(A,B,D,G,H) > m23(E) >m23(G) > m23(B) > m23(E,H) > m23(θ). A value of m for the disease is the largest value, it is 0.312079. It can be concluded that based on the results combination of all symptoms selected, the disease is disease A with confidence level is 0.312079, or 31.21%. However, if the combination done only based on symptoms contained rule A namely combination symptoms A001, A002, A003, A004, A005, and A006, the results of the confidence level for disease A is 96.11%.

Example calculation for the second case can be seen as follows:

The symptoms selected are: A006, H002, H003, H004, H005, H006 and H007. Then these symptoms will be classified into disease A, B, D, G and H. Value for A006 is 0.8, H002 is 0.5, H003 is 0.8, H004 is 0.7, H005 is 0.7, H006 is 0.7 and H007 is 0.8. Then the value on any evidence contained in H disease can be calculated using the formula DST combination as follows:

Known:

θ = {A, B, D, E, G, H}

In this case there is evidence e1 being support the hypothesis for disease A, B, D, G, H with m = 0.8, which can be written as follows:

A006 = A, B, D, G, H

m1(A, B, D, G, H) = 0.8

m1(θ) = 1-0.8 = 0.2 ……..(3)

Then there is evidence e2 supporting the hypothesis for disease H with m = 0.5, which can be written as follows:

H002 = H

m2(H) = 0.5

m2(θ) = 1-0.5 = 0.5

First, combine the first symptoms (e1) and the second symptoms (e2) using equation Dempster's Rule of Combination to obtain a new value m which is shown as follows:

Table 4.20: Combination e1 and e2

	(H) 0.5	θ 0.5
(A, B, D, G, H) 0.8	(H) 0.4	(A, B, D, G, H) 0.4
θ 0.2	(H) 0.1	⊕ 0.1

By use of the Dempster rule then obtained value for m3 as follows:

M3(H) = 0.4+0.1/1-0= 0.5 ……..(5)

M3(A, B, D, G, H)= 0.4/1-0 = 0.4 ……..(5)

M3(θ) = 0.1/1-0= 0.1 ……..(5)

Then, combine the value of m3 with evidence e3 which supports the hypothesis H with a value of m = 0.8, can be written as follows:

H003 = H

M4(H) = 0.8

M4(θ) = 0.2

Combine using equation Dempater's Rule of Combination to obtain new m5 value is shown as follows:

Table 4.21: Combination with e3

	(H) 0.8	θ 0.2
(H) 0.5	(H) 0.4	(H) 0.1
(A, B, D, G, H) 0.4	(H) 0.32	(A, B, D, G, H) 0.08
θ 0.1	(H) 0.08	⊕ 0.02

By use of the Dempster rule then obtained value for m5 as follows:

M5(H) = 0.4+0.32+0.08+0.1/1-0= 0.9 ……..(5)

M5(A, B, D, G, H)= 0.08/1-0= 0.08 ……..(5)

M5(θ) = 0.02/1-0= 0.02 ……..(5)

Then, combine the value of m5 with evidence e4 which supports the hypothesis H with a value of m = 0.7, can be written as follows:

H004 = H

M6(H) = 0.7

M6(θ) = 0.3

Combine using equation Dempater's Rule of Combination to obtain new m7 value is shown as follows:

Table 4.22: Combination with e4

	(H) 0.7	θ 0.3
(H) 0.9	(H) 0.63	(H) 0.27
(A, B, D, G, H) 0.08	(H) 0.056	(A, B, D, G, H) 0.024
θ 0.02	(H) 0.014	⊕ 0.006

By use of the Dempster rule then obtained value for m7 as follows:

M7(H) = 0.63+0.056+0.014+0.27/(1-0) = 0.97 ……..(5)

M7(A, B, D, G, H)= 0.024/1-0= 0.024 ……..(5)

M7(θ) = 0.006/(1-0) = 0.006 ……..(5)

Then, combine the value of m7 with evidence e5 which supports the hypothesis H with a value of m = 0.7, can be written as follows:

H005 = H

M8(H) = 0.7

M8(θ) = 0.3

Combine using equation Dempater's Rule of Combination to obtain new m9 value is shown as follows:

Table 4.23: Combination with e5

	(H) 0.7	θ 0.3
(H) 0.97	(H) 0.679	(H) 0.291
(A, B, D, G, H) 0.024	(H) 0.0168	(A, B, D, G, H) 0.0072
θ 0.006	(H) 0.0042	⊕ 0.0018

By use of the Dempster rule then obtained value for m9 as follows:

M9(A) = 0.679 +0.0168+0.0042+0.291/(1-0) = 0.991 ……..(5)

M9(A, B, D, G, H)= 0.0072/1-0= 0.0072 ……..(5)

M9(θ) = 0.0018/(1-0) = 0.0018 ……..(5)

Then, combine the value of m9 with evidence e6 which supports the hypothesis E, F, H with a value of m = 0.7, can be written as follows:

E002/H006 = E, F, H

M10(E, F, H) = 0.7

M10(θ) = 0.3

Combine using equation Dempater's Rule of Combination to obtain new m11 value is shown as follows:

Table 4.24: Combination with e6

	(E,F,H) 0.7	θ 0.3
(H) 0.991	(H) 0.6937	(H) 0.2973
(A, B, D, G, H) 0.0072	(H) 0.00504	(A, B, D, G, H) 0.00216
θ 0.0018	(E,F,H) 0.00126	⊕ 0.00054

By use of the Dempster rule then obtained value for m11 as follows:

M11(H) = 0.6937+0.00504+0.2973/(1-0) = 0.99604 ……..(5)

M11(A,B,D,G,H)= 0.00216/(1-0) = 0.00216 ……..(5)

M11(E,F,H) = 0.00126/(1-0) = 0.00126 ……..(5)

M11(θ) = 0.00054/(1-0) = 0.00054 ……..(5)

Then, combine the value of m11 with evidence e7 which supports the hypothesis H with a value of m = 0.8, can be written as follows:

H007 = H

M12(H) = 0.8

M12(θ) = 0.2

Combine using equation Dempater's Rule of Combination to obtain new m13 value is shown as follows:

Table 4.25: Combination with e7

	(H) 0.8	θ 0.2
(H) 0.99604	(H) 0.796832	(H) 0.199208
(A, B, D, G, H) 0.00216	(H) 0.001728	(A, B, D, G, H) 0.000432
(E,F,H) 0.00126	(H) 0.001008	(E,F,H) 0.000252
θ 0.00054	(H) 0.000432	⊕ 0.000108

By use of the Dempster rule then obtained value for m13 as follows:

M13(H) = 0.796832+0.001728+0.001008+0.000432/(1-0)

= 0.999208 ……..(5)

M13(E,F,H) = 0.000252/(1-0) = 0.000252 ……..(5)

M13(A,B,D,G,H)= 0.000432/(1-0) = 0.000432 ……..(5)

M13(θ) = 0.000108/(1-0) = 0.000108 ……..(5)

Based on the calculation above can be compared to the value of m for every possible disease namely m13(H)> m13(A,B,D,G,H) > m13(E,F,H) > m13(θ). The m value for disease H is the highest, it is 0.999208. The calculation for others case using Dempster Shafer method will be explained in appendix 1.

4.3 Calculation of Error Rate

In calculating the value of trust in a case, sometimes the facts contained in the knowledge base does not all happen. It is possible that there are one or more facts that are not experienced by the patient. Thus need for the calculation of the

error rate between the accuracy of all of the facts and some (not all) the facts in each hypothesis. Both calculations will also be carried out for each method. At table 4.26 just written symptom codes or fact codes occured in all cases or hypotheses, information on codes can be seen in Table 4.1. Error rate calculation results can be seen in Table 4:26 as follows:

Table 4.26: Result of Error Rate

Case	Symptoms	Result	Error Rate
1	A001, A002, A003, A004, A005, A006	CF= 0.9922 DS= 0.9611	CF= 0.52% DS= 2.59%
	A001, A002, A003, A004, A006	CF= 0.9870 DS= 0.9352	
2	B001, B002, B003, A006	CF= 0.946 DS= 0.775	CF= 0.6% DS= 2.5%
	A006, B001, B002	CF= 0.94 DS= 0.75	
3	D001,A006	CF= 0.96 DS=0.80	CF= 0% DS= 0%
	D001,A006	CF=0.96 DS=0.80	
4	E001, E002, E003	CF= 0.976 DS= 0.92	CF= 5.6% DS= 0%
	E001, E003	CF= 0.92 DS= 0.92	
5	F001, F002, E002	CF= 0.982 DS= 0.94	CF= 4.2% DS= 0%
	F001, F002	CF= 0.94 DS= 0.94	

6	G001, G002, G003, G004, A006	CF= 0.9984 DS= 0.984	CF= 0.16% DS= 2.4%
	G001, G003, G004, A006	CF= 0.9968 DS= 0.96	
7	E002, A006, H002, H003, H004, H005, H007	CF= 0.99989 DS= 0.9992	CF= 0.01% DS= 0.18%
	A006, H002, H003, H004, E002, H007	CF= 0.99978 DS= 0.99736	

As an example explanation for the case or hypothesis 1, if all the facts (symptoms) A disease occurs namely A001, A002, A003, A004, A005, A006 then the value of trust for a disease in CF method amounted 0.9922 or 99.22% and the DS method amounted 0.9611 or 96.11%. Meanwhile, if the fact that the case was reduced by one fact (A005) of the overall facts on a disease namely A001, A002, A003, A004, A006 then the value of trust for a disease in CF method of 0.9870 or 98.70% and the DS method of 0.9352 or 93.52% . Furthermore, the error rate will be calculated value between 6 and 5 facts that occurred, the calculation is done by taking the difference between the value of CF disease A with 6 facts and the value of CF disease A with 5 facts then multiplied by 100%, as well as the DS method. The obtained results for the error rate disease A at 0.52% in CF method and 2.59% on DS method. Detailed calculations for the entire case can be found in Appendix 1.

4.4 Comparative Analysis

Calculations for each method performed by testing eight cases according to the number of diseases data in previous studies. Based on the calculations have been done to compare the methods of Certainty Factor and Dempster Shafer of the obtained results as shown in Table 4.27 and and the graph of value can be seen in figure 4.1.

Table 4.27: Result of Calculation

Criteria	**CF (%)**	**DS (%)**
A	99.22	96.11
B	94.6	77.5
C	60	60
D	96	80
E	97.6	92
F	98.2	94
G	99.84	98.4
H	99.98	99.92
AVG	93.16	87.3225

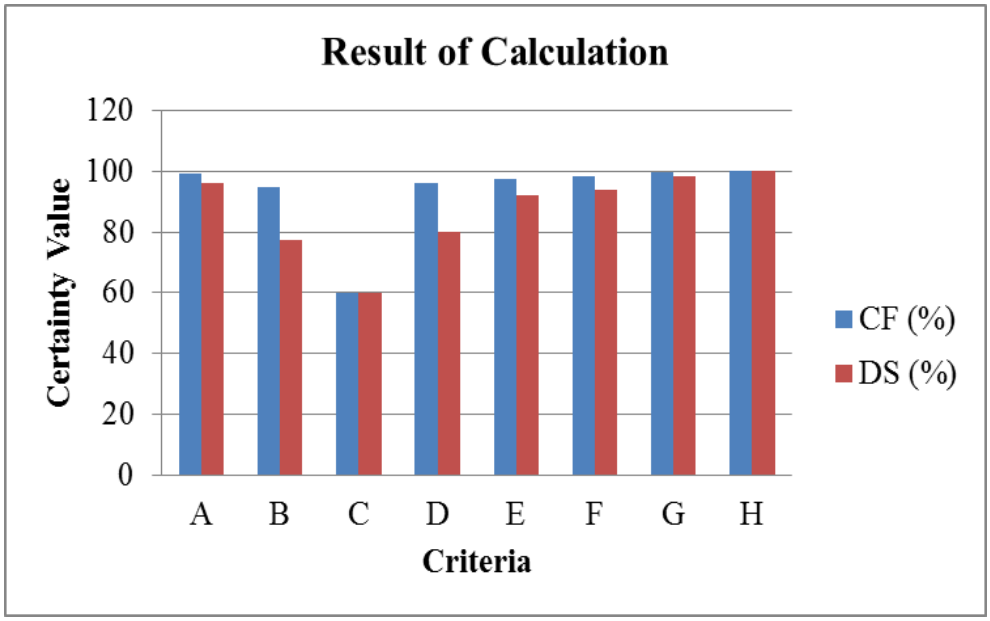

Figure 4.1: Result of Calculation

Comparative analysis will be performed using the Open Decision Maker tool with AHP approach (Analytical Hierarchy Process). The use of these tool aims to prove and strengthen the comparison of manual calculations. In the use of the Open Decision Maker, the first step is to determine alternatives and criteria required. Then it will be used the way the pair wise comparison is to provide an assessment or weights for each pair criteria of in each alternatives and each pair alternative in each criterion. Comparison of methods with tools is based on the calculation values contained in Table 4.27. In this case, Certainty Factor and Dempster Shafer method will be used as an alternative, while the hypothesis A to H will be used as a criterion. Weighting can be performed by using a scale has been made by researcher. The scale may represent the difference in value between the value at each hypothesis in each method and the differences value hypothesis

of the two methods among criteria. Determination of scale to give weight to the alternatives and criteria can be seen in Table 4.28.

Table 4.28: Scales of Open Decision Maker

Scales ODM	
Range	Scale
0 - 1,99	1
2 - 3,99	2
4 - 5,99	3
6 - 7,99	4
8 - 9,99	5
10 - 11,99	6
12 – 13,99	7
14 – 15,99	8
16 – 17,99	9

In determining the weights for each alternative, it will be calculated difference between value with alternatives CF for criteria A and the value of the alternative DS for criteria A. Then the difference proceeds will be adjusted to the scale that has been made. Assigning weights to the scale will be done toward greater value alternative. This is done until the last criteria. Assigning weights will be used in calculating the ranking value for each alternative.

Table 4.29: Weighting Alternative

Criteria	Alternative		Quarrel of CF & DS	Weight
	CF (%)	DS (%)		
A	99.22	96.11	3.11	2
B	94.6	77.5	17.1	9
C	60	60	0	1
D	96	80	16	9
E	97.6	92	5.6	3
F	98.2	94	4.2	3
G	99.84	98.4	1.44	1
H	99.98	99.92	0.06	1

After performing weighting for alternative, the next step is giving weight to each pair of criteria. It is used to calculate a rating value for each criterion of both methods. The means used to give weight is to compare the difference value between criteria of two alternatives. Scale is used to perform the weighting of criteria based on the table 4.28. Giving scale weights between criteria can be seen in table 4.30.

Table 4.30: Weighting Criteria

Criteria		Quarrel of Criteria	Weight	Criteria		Quarrel of Criteria	Weight
A	3.11	13.99	7	E	5.6	5.6	3
B	17.1			C	0		
C	0	3.11	2	F	4.2	4.2	3
A	3.11			C	0		
D	16	12.89	7	G	1.44	1.44	1

A	3.11			C	0		
E	5.6	2.49	2	H	0.06	0.06	1
A	3.11			C	0		
F	4.2	1.09	1	E	5.6	10.4	6
A	3.11			D	16		
G	1.44	1.67	1	F	4.2	11.8	6
A	3.11			D	16		
H	0.06	3.05	2	G	1.44	14.56	8
A	3.11			D	16		
C	0	17.1	9	H	0.06	15.94	8
B	17.1			D	16		
D	16	1.1	1	F	4.2	1.4	1
B	17.1			E	5.6		
E	5.6	11.5	6	G	1.44	4.16	3
B	17.1			E	5.6		
F	4.2	12.9	7	H	0.06	5.54	3
B	17.1			E	5.6		
G	1.44	15.66	8	G	1.44	2.76	2
B	17.1			F	4.2		
H	0.06	17.04	9	H	0.06	4.14	3
B	17.1			F	4.2		
D	16	16	9	H	0.06	1.38	1
C	0			G	1.44		

At table 4.31 can be seen the rating result for alternative that has been calculated. Alternative Certainty Factor (CF) is superior than alternative Dempster Shafer (DS), which is the value for the alternative CF at 82.54% while the value of alternative DS is equal to 17.46%.

Table 4.31: Alternative Ranking

	Name	Value
1	CF	82.54%
2	DS	17.46%

The ranking shows that of the eight criteria that have been tested, alternative CF has more value greater than the alternative DS. On criteria B and D, weights for alternative CF is at 90.00%, while for alternative DS is at 10.00%. The numbers have many difference, it is because the scale that has been determined for criteria B and D on alternative CF has very much difference with the criteria B and D on alternative DS. On criteria A, the weights for alternative CF is at 66.67%, while for alternative DS is at 33.33%. On criteria E and F, the weights for alternative CF is at 75.00%, while for alternative DS is at 25.00%. The numbers has a considerable difference, it is because predetermined scale for criteria A, E and F in alternative CF has very much difference with the criteria A, E and F on alternative DS. Then, the criterion C, G and H both alternatives have the same weight is 50.00%. Each of these values can be seen in Table 4.32 and the graph of value can be seen in figure 4.2.

Table 4.32: Alternative Main Criteria Matrix

	A	B	C	D	E	F	G	H
CF	66.67%	90.00%	50.00%	90.00%	75.00%	75.00%	50.00%	50.00%
DS	33.33%	10.00%	50.00%	10.00%	25.00%	25.00%	50.00%	50.00%

Consistency ratio: 0.0179 (Critical consistency ratio: 0.1)

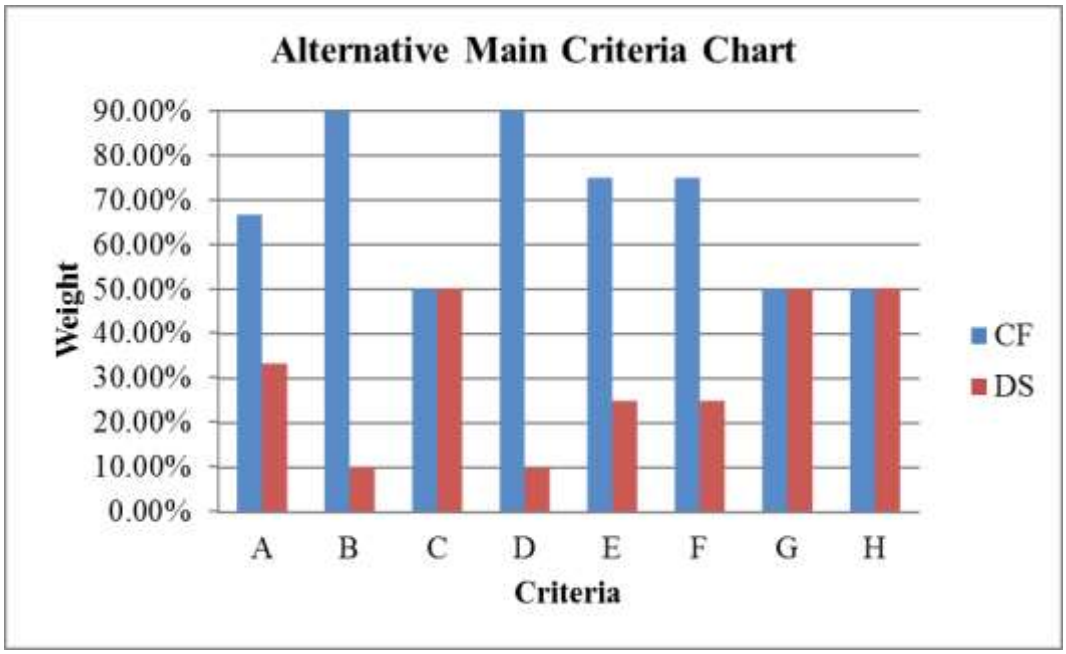

Figure 4.2: Alternative Main Criteria Chart

In calculating the weights for ranking alternatives, then use the default values for the critical consistency ratio is 0.1. This value will also be used when calculating the value Consistency ratio to generate the values of the alternative main criteria matrix. In this case, has obtained consistency ratio value is 0.0179, it indicates that the inconsistencies opinions of decision makers still acceptable and do not need to rehash the judgment because if the pair-wise comparison matrix has CR value > 0.1, the assessment needs to be repeated.

Based on the result of the weights calculation in table 4.30, it is resulted criteria ranking of two alternatives as shown in table 4.33. Criterion B is the most superior criterion, because the value of the difference between the two alternatives

on these criteria is the greatest value is 35.46%. While the smallest value is the criteria H, it is 3.10%.

Table 4.33: Main Criteria Weighting

	Name	Value
1	B	35.46%
2	D	34.22%
3	E	8.19%
4	F	7.01%
5	A	5.19%
6	G	3.68%
7	C	3.16%
8	H	3.10%

CHAPTER V

CONCLUSION REMARKS

5.1 Conclusion

Based on the description above it can be concluded about the comparative analysis Certainty Factor and Dempster Shafer method as follows:

1. Knowledge and experience of expert on infectious diseases in toddler can be processed and represented by Forward Chaining as inference engine and the acquisition value of certainty or belief can be done through manual calculation.
2. The calculation to obtain the value of belief in each case can be performed by using uncertainty approaches such as Certainty Factor and Dempster Shafer methods.
3. The result of a comparative analysis between the two methods shows that the Certainty Factor method is superior in generating a higher level of belief in more cases than Dempster Shafer method. This is shown by the results of data processing confidence level of both methods using Open Decision Maker application. Certainty Factor method obtain value as big as 82.54%, while Dempster Shafer method obtain value as big as 17.46%from processing of eight cases. However, the level of belief obtained by each method for each hypothesis has not much difference significantly. In the calculation of the Dempster Shafer method, resulting hypotheses are more varied, it is because the entire evidence selected will be combined with each other. While Certainty

Factor method, the calculation is done by sorting or grouping directly into the rules of evidences has been made so that the combination only limited evidence contained in any rules.

5.2 Suggestion

In this study, the comparisons were performed only using eight cases from one expert to obtain data on the level of belief. The result of study is limited manual calculations and has not been implemented into the system. Therefore, further research is expected so that the analysis of comparison in determining the uncertainty method performed with more cases, the data come from another expert, and also can be tested by using statistical tests. Then, both methods can be implemented into a system so that can be utilized by the community in diagnosing infectious diseases in toddlers.

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APPENDIX 1

Table 5.1 shows value for each symptom in each disease.

Table 5.1: Decision Table

Code	Symptoms	Disease (Case)							
		A	B	C	D	E	F	G	H
A001	Spleen enlarges slightly	0.1							
A002	Child has a rash (redness of skin) is flat, especially on the chest and abdomen and sometimes spreads to the face, arms and legs	0.7							
A003	Can swelling of lymph nodes in the back of the head, neck next to the side and behind the ears	0.6							
A004	Despite the high fever, but the child remained conscious and active	0.5							
A005	When body temperature started to increase, 5-10% of patients experienced febrile seizures (seizures due to high fever)	0.4							
A006	Fever	0.8	0.8		0.8			0.8	0.8
B001	Respiratory disorders		0.5						
B002	After passing 2 - 4 days, the rash spreads to the line of the body, arms and legs		0.4						
B003	Rash (like a punch) on both cheeks		0.1						
C001	There is a rash of small blisters containing pus and scab around the face, hands, head			0.7					
D001	After one or two days, appeared spots - red color and become blisters filled with water				0.8				
E001	Sometimes breathing sounds when breathing or after coughing					0.6			

E002	Flu/Cold					0.7	0.7		0.7
E003	Persistent cough discontinuous and can choke or vomit					0.8			
F001	Glands at the back of the neck will swell						0.7		
F002	Speckled rash that appears within one or two days - first in the face, then the rest of the body						0.8		
G004	Difficult to chew and swallow							0.8	
G003	Headache							0.5	
G002	Dry mouth							0.8	
G001	The gland swollen and tender under the ears and under the chin							0.6	
H002	White patches in the mouth (Koplik spots)								0.5
H003	The rash appears on the third or fourth day								0.8
H004	The spots will be flushed and more and more, but not itchy.								0.7
H005	Coughing hard								0.7
H007	Watery eyes, inflamed, red								0.8

Descriptions:

A : Roseola infatum

B : Red Cheek Syndrome (Parvovirus B19)

C : Impetigo

D : Chikenpox

E : Whooping Cough

F : Rubela (German Measles)

G : Mumps

H : Measles (rubeola, measles 9 days)

Calculations Technique of Certainty Factor Method for each case based on rules are as follows:

Case A:

Case A indicates disease A (Roseola Infantum) with six evidences (e), there are avidence(e) A001, A002, A003, A004, A005 and A006. The detail name of evidence can be seen at table 5.1.

CF(A1) = CF(A001) + CF(A002) * [1-CF(A001)] = 0,1 + 0,7* [1 – 0,1]

= 0,73 ……..(combination e1 and e2)

CF(A2) = CF(A003) + CF(A1) * [1-CF(A003)] = 0,6+ 0,73 * [1 – 0,6]

= 0,892 ……..(combination A1 and e3)

CF(A3) = CF(A004) + CF(A2) * [1-CF(A004)] = 0,4 + 0,892* [1 – 0,4]

= 0,935 ……..(combination A2 and e4)

CF(A4) = CF(A005) + CF(A3) * [1-CF(A005)] = 0,4+ 0,935 * [1 – 0,4]

= 0,961 ……..(combination A3 and e5)

CF(A5) = CF(A006) + CF(A4) * [1-CF(A006)] = 0,8+ 0,961 * [1 – 0,8]

= 0,9922 ……..(combination A4 and e6)

Case B:

Case B indicates disease B (Red Cheek Syndrom) with six evidences (e), there are avidence(e) A006, B001, B003 and B002. The detail name of evidence can be seen at table 5.1.

CF(B1) = CF(A006) + CF(B002) * [1-CF(B001)] = 0,8 + 0,4* [1 – 0,8]

= 0,88 ……..(combination e1 and e2)

CF(B2) = CF(B003) + CF(B1) * [1-CF(B003)] = 0,1+ 0,88 * [1 – 0,1]

= 0,892 ……..(combination B1 and e3)

CF(B3) = CF(B002) + CF(B2) * [1-CF(B002)] = 0,5 + 0,892* [1 – 0,5]

= 0,946 ……..(combination B2 and e4)

Case C:

Case C indicates disease C (Impetigo) with an evidences (e), there is avidence(e) C001. The detail name of evidence can be seen at table 5.1.

CF(C1) = 0.7

Case D:

Case D indicates disease D (Chikenpox) with two evidences (e), there are avidence(e) A006 and D001. The detail name of evidence can be seen at table 5.1.

CF(D1) = CF(D001) + CF(A006) * [1-CF(D001)]= =0,8 + 0,8* [1 – 0,8]

=0,96 ……..(combination e1 and e2)

Case E:

Case E indicates disease E (Whooping Cough) with three evidences (e), there are avidence(e) E001, E002 and E003. The detail name of evidence can be seen at table 5.1.

CF(E1) = CF(E001) + CF(E002) * [1-CF(E001)] = 0,7 + 0,8* [1 – 0,7]

= 0,94 ……..(combination e1 and e2)

CF(E2) = CF(E003) + CF(E1) * [1-CF(E003)] = 0,6+ 0,94 * [1 – 0,6]

= 0,976 ……..(combination E1 and e3)

Case F:

Case F indicates disease F (Rubela/German Measles) with three evidences (e), there are avidence(e) F001, F002 and E002. The detail name of evidence can be seen at table 5.1.

CF(F1) = CF(F001) + CF(F002) * [1-CF(F001)] = 0,7 + 0,8* [1 – 0,7]

= 0,91 ……..(combination e1 and e2)

CF(F2) = CF(E002) + CF(F1) * [1-CF(3)] = 0,7+ 0,91 * [1 – 0,7]

= 0,982 ……..(combination F1 and e3)

Case G:

Case G indicates disease G (Mumps) with five evidences (e), there are avidence(e) G001, G002, G003, G004 and A006. The detail name of evidence can be seen at table 5.1.

CF(G1) = CF(G001) + CF(G002) * [1-CF(G001)] = 0,6 + 0,8* [1 – 0,6]

= 0,92 ……..(combination e1 and e2)

CF(G2) = CF(G003) + CF(G1) * [1-CF(G003)] = 0,5+ 0,92 * [1 – 0,5]

= 0,96 ……..(combination G1 and e3)

CF(G3) = CF(G004) + CF(G2) * [1-CF(G004)] = 0,8 + 0,96* [1 – 0,8]

= 0,992 ……..(combination G2 and e4)

CF(G4) = CF(A006) + CF(G3) * [1-CF(A006)] = 0,8+ 0,992 * [1 – 0,8]

= 0,9984 ……..(combination G3 and e5)

Case H:

Case H indicates disease H (Measles (rubeola, measles 9 days)) with eight evidences (e), there are avidence(e) A006, H002, H003, H004, H005, E002 and H007. The detail name of evidence can be seen at table 5.1.

CF(H1) = CF(A006) + CF(H002) * [1-CF(A006)] = 0,8 + 0,5* [1 – 0,8]

= 0,9 ……..(combination e1 and e2)

CF(H2) = CF(H003) + CF(H1) * [1-CF(H003)] = 0,8+ 0,9 * [1 – 0,8]

= 0,98 ……..(combination H1 and e3)

CF(H3) = CF(H004) + CF(H2) * [1-CF(H004)] = 0,7 + 0,98* [1 – 0,7]

= 0,994 ……..(combination H2 and e4)

CF(H4) = CF(H005) + CF(H3) * [1-CF(H005)] = 0,7+ 0,994 * [1 – 0,7]

= 0,9982 ……..(combination H3 and e5)

CF(H5) = CF(E002) + CF(H4) * [1-CF(E002)] = 0,7+ 0,9982 * [1 – 0,7]

= 0,99946 ……..(combination H4 and e6)

CF(H7) = CF(H007) + CF(H4) * [1-CF(H007)] = 0,8+ 0,99946 * [1 – 0,8]

= 0,99989 ……..(combination H5 and e7)

Calculations Technique of Dempster Shafer Method for each case based on rules are as follows:

Case A:

Case A indicates disease A (Roseola Infantum) with six evidences (e), there are avidence(e) A001, A002, A003, A004, A005 and A006. The detail name of evidence can be seen at table 5.1.

A001 = A

m1(A) = 0.1

m1(θ) = 1-0.1 = 0.9

A002 = A

m2(A) = 0.7

m2(θ) = 1-0.7 = 0.3

Table 5.2: Combination e1 and e2

	(A) 0.7	θ 0.3
(A) 0.1	(A) 0.07	(A) 0.03
θ 0.9	(A) 0.63	⊕ 0.27

M3(A) = 0.73

M3(θ) = 0.27

A003 = A

M4(A) = 0.6

M4(θ) = 0.4

Table 5.3: Combination with e3

	(A) 0.73	θ 0.27
(A) 0.6	(A) 0.438	(A) 0.162
θ 0.4	(A) 0.292	⊕ 0.108

M5(A) = 0.892

M5(θ) = 0.108

A004 = A

M6(A) = 0.4

M6(θ) = 0.6

Table 5.4: Combination with e4

	(A) 0.4	θ 0.6
(A) 0.892	(A) 0.3568	(A) 0.5352
θ 0.108	(A) 0.0432	⊕ 0.0648

M7(A) = 0.3568+0.5352+0.0432/(1-0) = 0.9352

M7(θ) = 0.0684/(1-0) = 0.0684

A005 = A

M8(A) = 0.4

M8(θ) = 0.6

Table 5.5: Combination with e5

	(A) 0.4	θ 0.6
(A) 0.9352	(A) 0.37408	(A) 0.56112
θ 0.0648	(A) 0.02592	⊕ 0.03888

M9(A) = 0.37408+0.56112+0.02592/(1-0) = 0.96112

M9(θ) = 0.03888/(1-0) = 0.03888

A006 = A,B,D,G,H

M10(A,B,D,G,H)= 0.8

M10(θ) = 0.2

Table 5.6: Combination with e6

	(ABDGH) 0.8	θ 0.2
(A) 0.96112	(A) 0.768896	(A) 0.192224
θ 0.03888	(ABDGH) 0.031104	⊕ 0.007776

M11(A) = 0.768896+0.192224/(1-0) = 0.96112

M11(A,B,D,G,H)= 0.031104/(1-0) = 0.031104

M11(θ) = 0.007776/(1-0) = 0.007776

Case B:

Case B indicates disease B (Red Cheek Syndrom) with six evidences (e), there are avidence(e) A006, B001, B003 and B002. The detail name of evidence can be seen at table 5.1.

A006 = A, B, D, G,H

M1(ABDGH) = 0.8

M1(θ) = 0.2

B001 = B

M2(B) = 0.4

M2(θ) = 0.6

Table 5.7: Combination e1 and e2

	(B) 0.5	θ 0.5
(ABDGH) 0.9	(B) 0.45	(ABDGH) 0.45
θ 0.1	(B) 0.05	⊕ 0.05

M3(B) = 0.5

M3(ABDGH) = 0.45

M3(θ) = 0.05

B002 = B

M4(B) = 0.5

M4(θ) = 0.5

Table 5.8: Combination with e3

	(B) 0.5	θ 0.5
(B) 0.5	(B) 0.25	(B) 0.25
(A, B, D, G, H) 0.45	(B) 0.225	(A, B, D, G, H) 0.225
θ 0.05	(B) 0.025	⊕ 0.025

M5(B) = 0.75

M5(ABDGH) = 0.225

M5(θ) = 0.025

B003 = B

M6(B) = 0.1

M6(θ) = 0.9

Table 5.9: Combination with e4

	(B) 0.1	θ 0.9
(B) 0.75	(B) 0.075	(B) 0.675
(A, B, D, G, H) 0.225	(B) 0.0225	(A, B, D, G, H) 0.2025
θ 0.025	(B) 0.0025	⊕ 0.0225

M7(B) = 0.775

M7(ABDGH) = 0.2025

M7(θ) = 0.0225

Case D:

Case D indicates disease D (Chikenpox) with two evidences (e), there are avidence(e) A006 and D001. The detail name of evidence can be seen at table 5.1.

A006 = A, B, D, G,H

M1(ABDGH) = 0.8

M1(θ) = 0.2

D001 = D

M2(D) = 0.8

M2(θ) = 0.2

Table 5.10: Combination e1 with e2

	(D) 0.8	θ 0.2
(ABDGH) 0.8	(D) 0.64	(ABDGH) 0.16
θ 0.2	(D) 0.16	⊕ 0.04

M3(D) = 0.8

M3(ABDGH) = 0.16

M3(θ) = 0.04

Case E:

Case E indicates disease E (Whooping Cough) with three evidences (e), there are avidence(e) E001, E002 and E003. The detail name of evidence can be seen at table 5.1.

E001 = E

M1(E) = 0.6

M1(θ) = 0.4

E002 = E,H,F

M2(EHF) = 0.7

M2(θ) = 0.3

Table 5.11: Combination e1 with e2

	(EHF) 0.7	θ 0.3
(E) 0.6	(E) 0.42	(E) 0.18
θ 0.4	(EHF) 0.28	⊕ 0.12

M3(E) = 0.6

M3(EHF) = 0.28

M3(θ) = 0.12

E003 = E

M4(E) = 0.8

M4(θ) = 0.2

Table 5.12: Combination with e3

	(E) 0.8	θ 0.2
(E) 0.6	(E) 0.48	(E) 0.12
(EHF) 0.28	(E) 0.224	(EHF) 0.056
θ 0.12	(E) 0.096	⊕ 0.024

M5(E) = 0.92

M5(EHF) = 0.056

M5(θ) = 0.024

Case F:

Case F indicates disease F (Rubela/German Measles) with three evidences (e), there are avidence(e) F001, F002 and E002. The detail name of evidence can be seen at table 5.1.

F001 = F

M1(F) = 0.7

M1(θ) = 0.3

F002 = E,H,F

M2(EHF) = 0.7

M2(θ) = 0.3

Table 5.13: Combination e1 with e2

	(EHF) 0.7	θ 0.3
(F) 0.7	(F) 0.49	(F) 0.21
θ 0.3	(EHF) 0.21	⊕ 0.09

M3(F) = 0.7

M3(EHF) = 0.21

M3(θ) = 0.09

F003 = F

M4(F) = 0.8

M4(θ) = 0.2

Table 5.14: Combination with e3

	(F) 0.8	θ 0.2
(F) 0.7	(E) 0.56	(E) 0.14
(EHF) 0.21	(E) 0.168	(EHF) 0.042
θ 0.09	(E) 0.072	⊕ 0.018

M5(F) = 0.94

M5(EHF) = 0.042

M5(θ) = 0.018

Case G:

Case G indicates disease G (Mumps) with five evidences (e), there are avidence(e) G001, G002, G003, G004 and A006. The detail name of evidence can be seen at table 5.1.

A006 = A, B, D, G,H

M1(ABDGH) = 0.8

M1(θ) = 0.

G001 = G

M2(G) = 0.6

M2(θ) = 0.4

Table 5.15: Combination e1 with e2

	(G) 0.6	θ 0.4
(ABDGH) 0.8	(G) 0.48	(ABDGH) 0.32
θ 0.2	(B) 0.12	⊕ 0.08

M3(G) = 0.6

M3(ABDGH) = 0.32

M3(θ) = 0.08

G002 = G

M4(G) = 0.6

M4(θ) = 0.4

Table 5.16: Combination with e3

	(G) 0.6	θ 0.4
(G) 0.6	(G) 0.36	(G) 0.24
(A, B, D, G, H) 0.32	(G) 0.192	(A, B, D, G, H) 0.128
θ 0.08	(G) 0.048	⊕ 0.032

M5(G) = 0.84

M5(ABDGH) = 0.128

M5(θ) = 0.032

G003 = G

M6(G) = 0.5

M6(θ) = 0.5

Table 5.17: Combination with e4

	(G) 0.5	θ 0.5
(G) 0.84	(G) 0.42	(G) 0.42
(A, B, D, G, H) 0.128	(G) 0.064	(A, B, D, G, H) 0.064
θ 0.032	(G) 0.016	⊕ 0.016

M7(G) = 0.92

M7(ABDGH) = 0.064

M7(θ) = 0.016

G004 = G

M8(G) = 0.8

M8(θ) = 0.2

Table 5.18: Combination with e5

	(G) 0.8	θ 0.2
(G) 0.92	(G) 0.736	(G) 0.184
(A, B, D, G, H) 0.064	(G) 0.0512	(A, B, D, G, H) 0.0128
θ 0.016	(G) 0.0128	⊕ 0.0032

M9(G) = 0.984

M9(ABDGH) = 0.0128

M9(θ) = 0.0032

Case H:

Case H indicates disease H (Measles (rubeola, measles 9 days)) with eight evidences (e), there are avidence(e) A006, H002, H003, H004, H005, E002 and H007. The detail name of evidence can be seen at table 5.1.

A006 = A, B, D, G, H

m1(A, B, D, G, H) = 0.8

m1(θ) = 1-0.8 = 0.2

H002 = H

m2(H) = 0.5

m2(θ) = 1-0.5 = 0.5

Table 5.19: Combination e1 and e2

	(H) 0.5	θ 0.5
(A, B, D, G, H) 0.8	(H) 0.4	(A, B, D, G, H) 0.4
θ 0.2	(H) 0.1	⊕ 0.1

M3(H) = 0.4+0.1/1-0= 0.5

M3(A, B, D, G, H)= 0.4/1-0 = 0.4

M3(θ) = 0.1/1-0= 0.1

H003 = H

M4(H) = 0.8

M4(θ) = 0.2

Table 5.20: Combination with e3

	(H) 0.8	θ 0.2
(H) 0.5	(H) 0.4	(H) 0.1
(A, B, D, G, H) 0.4	(H) 0.32	(A, B, D, G, H) 0.08
θ 0.1	(H) 0.08	⊕ 0.02

M5(H) = 0.4+0.32+0.08+0.1/1-0= 0.9

M5(A, B, D, G, H)= 0.08/1-0= 0.08

M5(θ) = 0.02/1-0= 0.02

H004 = H

M6(H) = 0.7

M6(θ) = 0.3

Table 5.21: Combination with e4

	(H) 0.7	θ 0.3
(H) 0.9	(H) 0.63	(H) 0.27
(A, B, D, G, H) 0.08	(H) 0.056	(A, B, D, G, H) 0.024
θ 0.02	(H) 0.014	⊕ 0.006

M7(H) = 0.63+0.056+0.014+0.27/(1-0) = 0.97

M7(A, B, D, G, H)= 0.024/1-0= 0.024

M7(θ) = 0.006/(1-0) = 0.006

H005 = H

M8(H) = 0.7

M8(θ) = 0.3

Table 5.22: Combination with e5

	(H) 0.7	θ 0.3
(H) 0.97	(H) 0.679	(H) 0.291
(A, B, D, G, H) 0.024	(H) 0.0168	(A, B, D, G, H) 0.0072
θ 0.006	(H) 0.0042	⊕ 0.0018

M9(A) = 0.679 +0.0168+0.0042+0.291/(1-0) = 0.991

M9(A, B, D, G, H)= 0.0072/1-0= 0.0072

M9(θ) = 0.0018/(1-0) = 0.0018

E002/H006 = E, F, H

M10(E, F, H) = 0.7

M10(θ) = 0.3

Table 5.23: Combination with e6

	(E,F,H) 0.7	θ 0.3
(H) 0.991	(H) 0.6937	(H) 0.2973
(A, B, D, G, H) 0.0072	(H) 0.00504	(A, B, D, G, H) 0.00216
θ 0.0018	(E,F,H) 0.00126	⊕ 0.00054

M11(H) = 0.6937+0.00504+0.2973/(1-0) = 0.99604

M11(A,B,D,G,H)= 0.00216/(1-0) = 0.00216

M11(E,F,H) = 0.00126/(1-0) = 0.00126

M11(θ) = 0.00054/(1-0) = 0.00054

H007 = H

M12(H) = 0.8

M12(θ) = 0.2

Table 5.24: Combination with e7

	(H) 0.8	θ 0.2
(H) 0.99604	(H) 0.796832	(H) 0.199208
(A, B, D, G, H) 0.00216	(H) 0.001728	(A, B, D, G, H) 0.000432
(E,F,H) 0.00126	(H) 0.001008	(E,F,H) 0.000252
θ 0.00054	(H) 0.000432	⊕ 0.000108

M13(H) = 0.796832+0.001728+0.001008+0.000432/(1-0) = 0.999208

M13(E,F,H) = 0.000252/(1-0) = 0.000252

M13(A,B,D,G,H)= 0.000432/(1-0) = 0.000432

M13(θ) = 0.000108/(1-0) = 0.000108

APPENDIX 2

The steps in using Open Decision Maker application for comparing both of methods are as follows [9]:

New file in Open Decision Maker

Figure 5.1 shows Open Decision Maker application when creating new goal for the problem, after we create the goal we can go to the next.

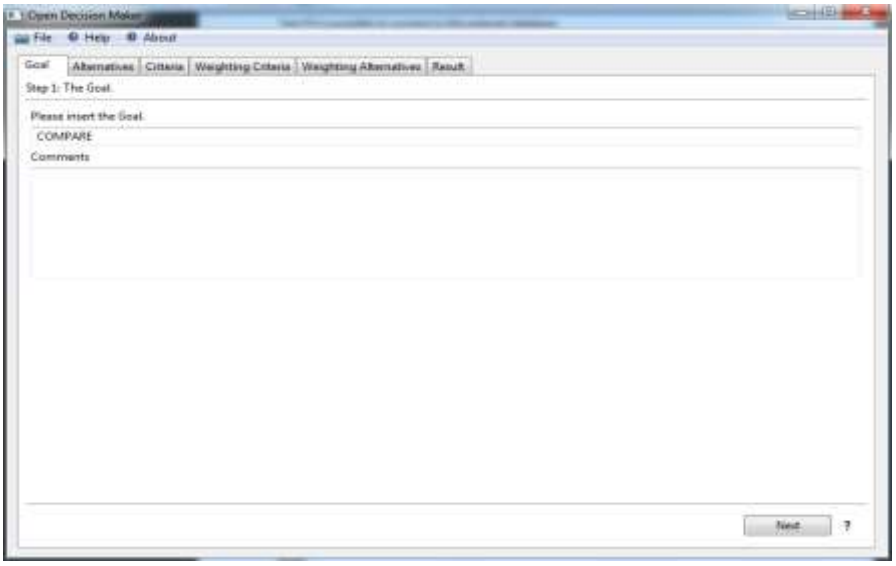

Figure 5.1: The Goal Description

Input The Alternatives

Figure 5.2 shows a page when we creating the alternative that we want, in this case the alternatives are Certainty Factor (CF) and Dempster Shafer (DS). There are buttons as follows:

Add alternative: Adds a new Alternative to the ODM Project

Edit alternative Name: Edits the name of the selected alternative

Add/edit description: Adds or edits the description of an alternative in the column behind the alternative name

Remove alternative: Removes the selected alternative from the decision making process

Comments: A section for general comments which are valid for all alternatives

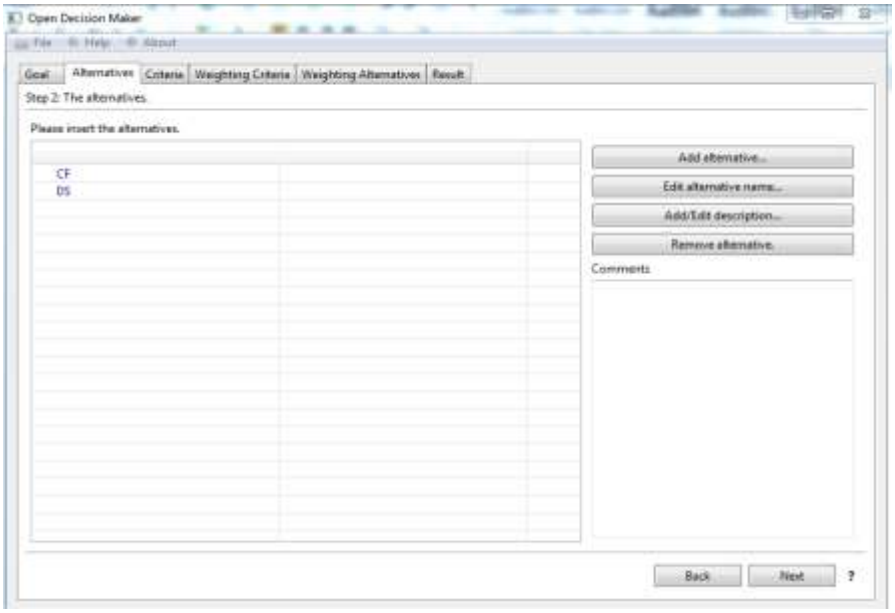

Figure 5.2: Create The Alternatives

Input The Criteria

Figure 5.3 shows a page when we creating the criteria that we want, in this case the criterias are eight hypothesis namely A, B, C, D, E, F, G and H. Criteria are the factors which are used to rate the alternatives. In the Criteria page, there are buttons as follows:

Add criterion: Adds a criterion to the ODM project

Add sub criterion: Adds a sub criterion to the selected criterion

Edit criterion name: Edits the name of the selected criterion

Add/Edit description: Adds a description to the selected criterion

Remove criterion: Removes the selected criterion from the current ODM project.

Comments: General comment filed for all criteria

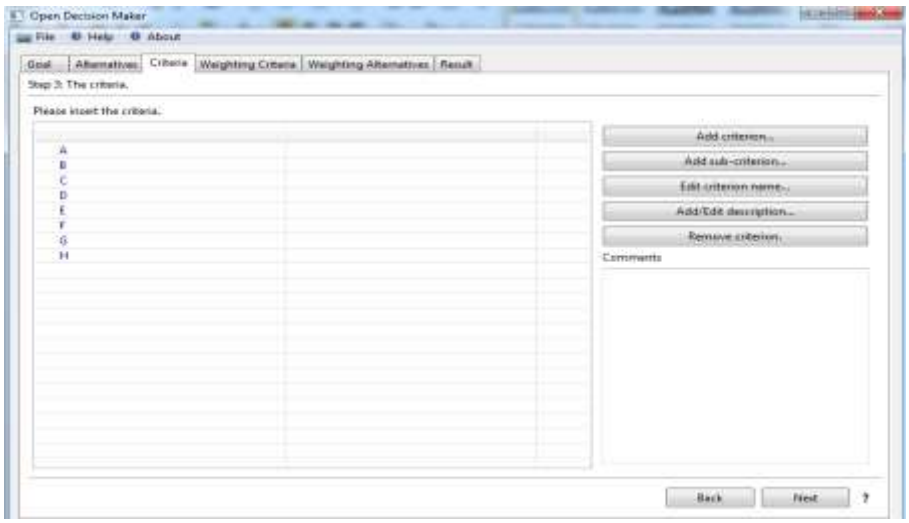

Figure 5.3: Create The Criterias

Weighting The Criteria

Figure 5.4 shows page to weighting criteria that we made, each criteria will be compared with others. In the Weighting alternative step we have to compare all criterions by pairs and have to decide which criteria is more/ higher (or equal) in the belief value. All criteria are listed in a tree structure on the left-hand side. We can weighting it using the scale has been made.

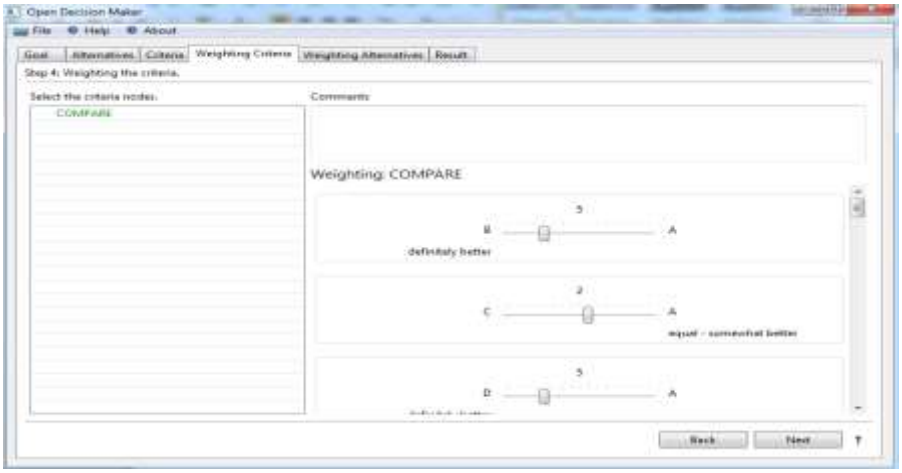

Figure 5.4: Weighting The Criterias

Weighting The Alternatives

Figure 5.5 shows page to weighting alternative in each criteria, there are alternative CF and DS in criteria A, B, c, d, E, F, G and H. In this step all alternatives have to be compared pair wise for decision criterion.

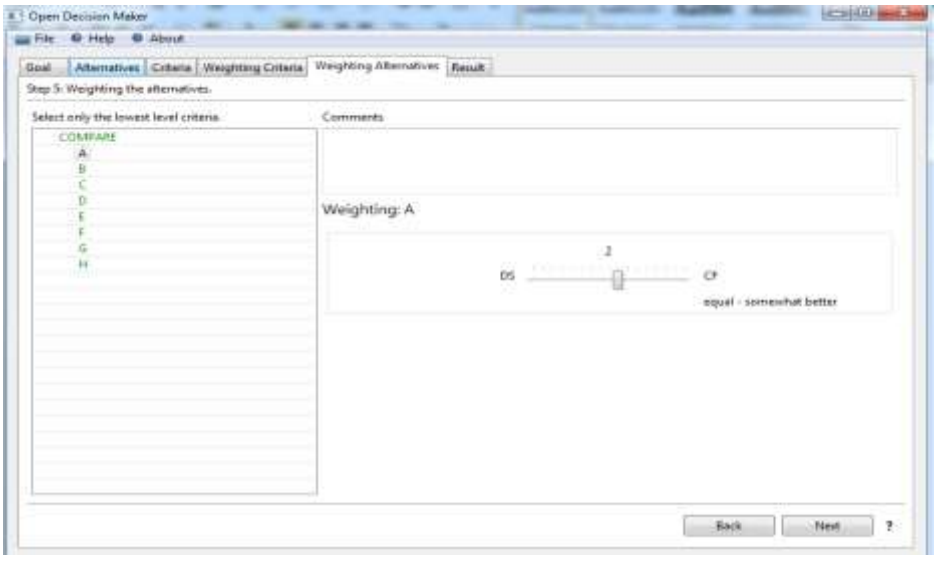

Figure 5.5: Weighting The Alternative

Result of Compare

Figure 5.6 shows the result of compare both alternatives, there are Alternative rangking, alternative/criterion matrix and consistency ratio.

In the Result/Ranking table the final ranking is displayed. The alternative with the highest value is the alternative which should be chosen. In the Consistency Ratio table the consistency of all criterion. A high consistency ratio is an indication of random/not logical ratings of the criterion weightings

Alternative/Criterion Matrix: in the alternative criterion matrix it is displayed how the alternatives scored considering the top level criteria.

Create PDF: A full report with all details of the current ODM project will be generated and opened.

Show Sensitivity: A simulation of the stability of the result will be opened, it is dispalyed at figure 5.7. In this window the user has the possibility to see how stable changes of the importance of top level criteria will affect the result of the ODM project

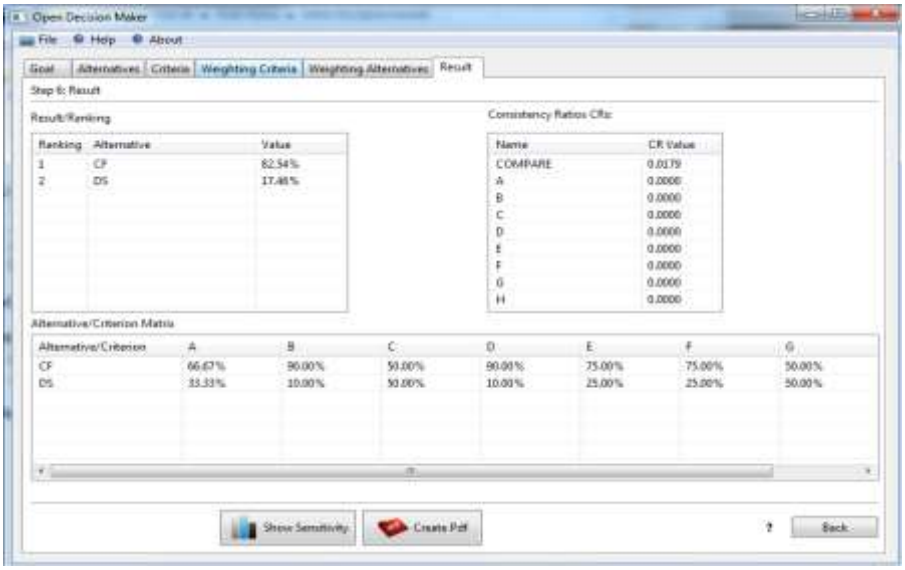

Figure 5.6: The Summary Result

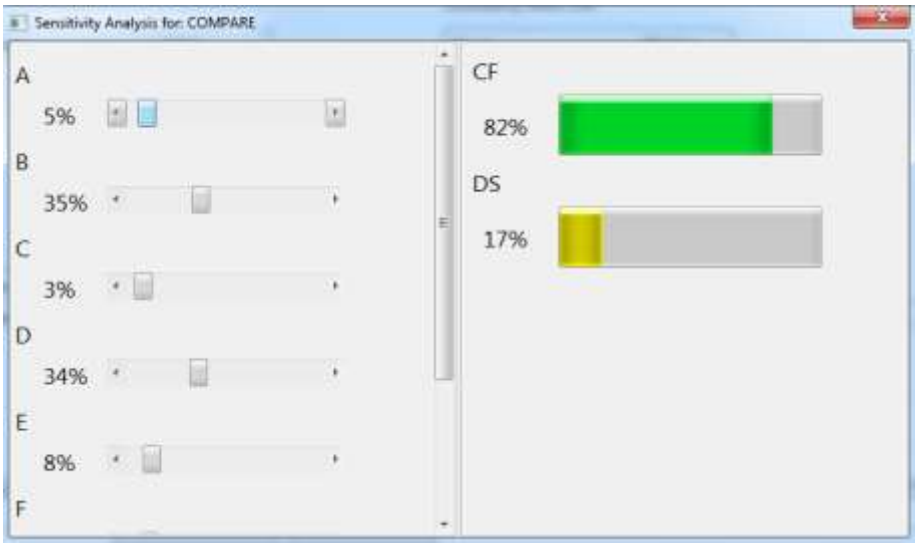

Figure 5.7: The Sencitivity Analysis